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How State Laws Compel Removal of Dust

An Analysis of the Legislation in Every State—
Standard Specifications for Dust Removal Systems

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SIXTEEN of the 48 states in this country have enacted legislation requiring the installation of dust removal apparatus in connection with the operation of grinding, polishing or buffing wheels. In ten other states where there are no specific laws on this subject, the general labor legislation is of such a character that the state factory inspection departments have the power to compel the employment of exhaust fans in foundries, machine shops or plating works where there are grinding, cleaning, buffing or polishing rooms. In 22 states there is no legislation on the subject of dust removal. These commonwealths are mostly in the agricultural sections of the south and west where there is relatively little industrial development. In the prominent manufacturing states of the north and east, only Maine, New Hampshire and Vermont have failed to pass specific legislation compelling the installation of efficient dust removal apparatus.

Most of the laws possess a broad character which allows the factory inspectors considerable latitude in determining what constitutes satisfactory and efficient apparatus. But in a few instance, notably New York and Wisconsin, elaborate specifications have been drawn up which cover the subject very fully. The states which now have specific laws regarding dust removal in force are as follows: Col-

FIG. 1—PRIMITIVE METHOD OF CLEANING CASTINGS EXPOSING WORKMAN TO DUST

FIG. 2—BUFFING WHEELS PROPERLY PROTECTED BY DUST EXHAUST HOODS

orado, Connecticut, Delaware, Illinois, Indiana, Iowa, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, New York, Ohio, Pennsylvania, Washington and Wisconsin.

That the subject is an important one is conceded on all sides and there is little doubt but that many states which now have no laws on this subject will take up the question in the next few years. Bills are now being framed or considered in Maine, Texas and Vermont.

Progressive employers have long been aware that efficient dust exhaust systems in polishing, cleaning or grinding rooms not only conserve the health and improve the comfort of employes, but also increase the output and lower the costs in these departments. For this reason the subject has been given special study by manufacturers of grinding machinery, fans, blowers, etc., so that today the employer has both very efficient and moderate priced apparatus at his command.

Lack of proper dust removal facilities exposes workmen to many diseases affecting the throat and lungs including bronchitis and tuberculosis. In some states employers are subject to suit and damages where such diseases can be shown to have been contracted amid unsanitary working conditions.

The Illinois law is specially comprehensive and some side lights are thrown on its provisions by a recent paper prepared by Barney Cohen, assistant chief of the department of factory inspection and published by the state. Portions of this paper are as follows:

"The Illinois department of factory inspection is ordering all hoods of an improper construction to be replaced by those that have the branch pipe connected to the hood at a point directly beneath that part of the wheel which comes in contact with the work and as near to the point of work on the wheel as the character of the work will permit. We also advise and urge that an additional suction be placed in the rear of the wheel near the center, in order that the light-floating dust that escapes the front suction may be caught up and carried off. Where such an additional suction is used, care must be taken to so design the two suctions that their combined area is equal to the area of the branch pipe into which they open. The light dust constitutes the dangerous elements and there is a sufficient amount of it passing the front intake of the hood to cause danger to the employes.

"Hoods must be of substantial character, so as to act as a guard for the wheel. Numerous accidents occur to workmen by pieces of material catching in the wheels and revolving with them. This is the case very frequently on buffing wheels, and as a result of too light hoods employes' hands are frequently badly mangled. Other important points in the construction of exhaust systems are to eliminate as many bends and elbows as possible. Install your dust collector as near to the fan as possible, and the fan as near to the wheel as possible. All branch pipes on blower systems where over three machines are connected should be equipped with blast gates for the purpose of equalizing the suction power, so that the pipes farthest away from the fan will receive the required suction.

"In the construction of an exhaust system the numerous prepared tables, as far as they apply to horsepower and revolutions per minute of fan for a given suction, should be used with caution, because no set table will apply to all systems; increase the resistance, and the horsepower and revolutions of fans must be increased; reduce the resistance and, vice versa, you can reduce your revolutions of fan and horsepower. In other words, the layout of practically every exhaust system involves problems that cannot be solved by the direct application of standard formulas, and only men of long mechanical experience should be entrusted with their design and installation. This condition has been brought to the attention of the department so often that the department feels the need of the enactment of a law compelling any man or firm engaged or liable to engage in the design and installation

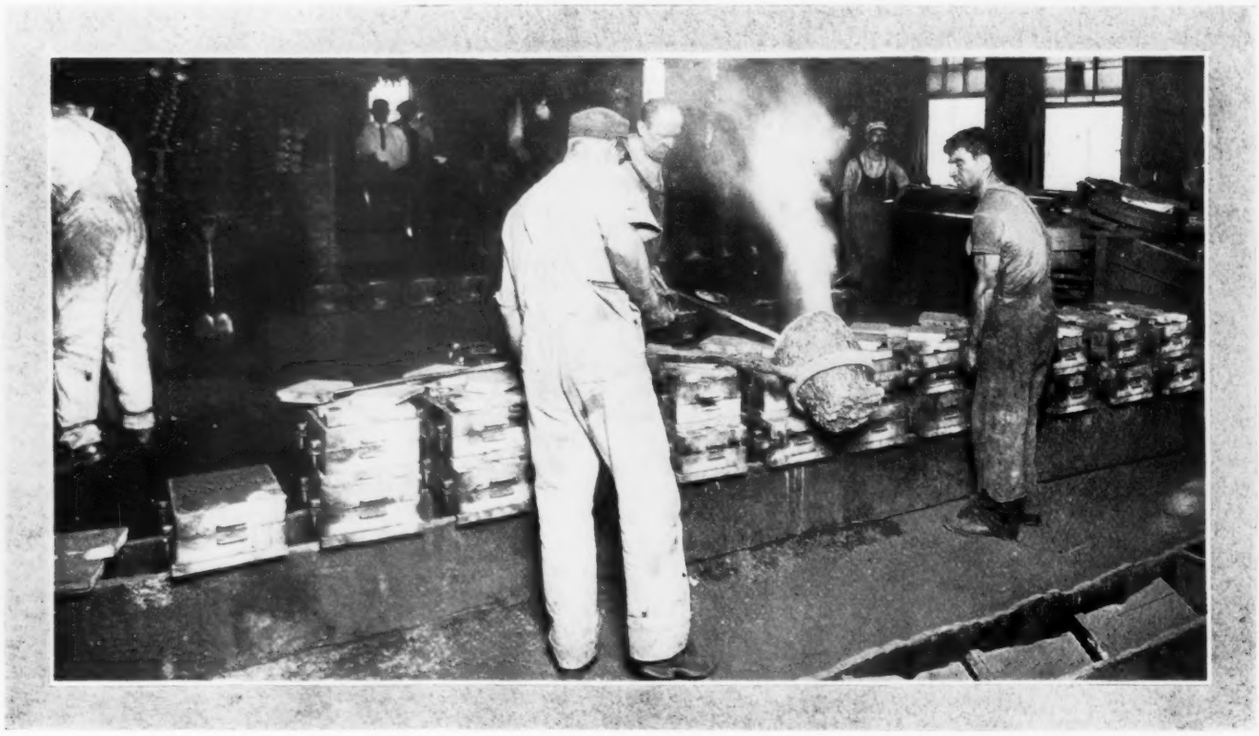


FIG. 3—CASTING YELLOW BRASS IN A CLOSED ROOM—WORKMEN SUBJECT TO ZINC FUMES

of exhaust systems to pass a rigid examination as to his fitness, and to be licensed in the same manner as a plumber or architect. The department feels that everyone engaged in the designing and installing of mechanical devices whose purpose it is to protect the life and health of men should show himself capable.

"A fault of several of the constructors of exhaust systems is an attempt by them to convince the manufacturer that the 5-inch suction power in the "U"-shaped tube, as required by the Illinois law, is not necessary. A 5-inch suction is necessary because it will extend far enough from the opening of the branch pipe to cover the zone of the wheel, thereby removing dangerous floating dust."

The specifications for dust removal systems issued by the state of New York were prepared by William Newell. In explanation of the specifications, the labor commissioner of the state makes the following comment:

"These specifications are issued with the view of bringing about the efficient removal of dust from grinding and buffing wheels. Their object is to prevent the construction of exhaust systems on such faulty designs as making the main suction duct much too small and not infrequently the same size throughout its length, running the branch pipes into the main at right angles and sometimes at the bottom of the main, too small a fan, too small a discharge pipe from the fan, too small a cyclone separator or dust collector, etc., with the result that the suction is entirely inadequate to carry off the dust, which then clogs the ducts and spreads about the room, to the injury of the workmen's health.

"A room free from dust is also productive of higher efficiency of both men and machinery. It has been proven time and again in actual practice that the output of a workman is increased if he works under healthful atmospheric conditions. Freedom from dust is also conducive to less wear and friction, and hence longer life, of machinery. Lastly, these specifications will protect manufacturers from spending their money on useless exhaust systems installed by ignorant or careless contractors."

The specifications are as follows:

Minimum sizes of branch pipes allowed for different sized emery or other grinding wheels:

Diameter of wheels	Maximum grinding surface, sq. ins.	Minimum diameter of branch pipe in ins.
6 in. or less, not over 1 in. thick	19	3
7 in. to 9 in. inclusive, not over 1½ in. thick	43	3½
10 in. to 16 in. inclusive, not over 2 in. thick	101	4
17 in. to 19 in. inclusive, not over 3 in. thick	180	4½
20 in. to 24 in. inclusive, not over 4 in. thick	302	5
25 in. to 30 in. inclusive, not over 5 in. thick	472	6

In case a wheel is thicker than given in the above tabulation, or if a disc instead of a regular wheel is used, it must have a branch pipe no smaller than is called for by its grinding surface, as given above.

Minimum sizes of branch pipes allowed for different sized buffing, polishing or rag wheels, as they are variously called, are as follows:

Diameter of wheels	Maximum grinding surface, sq. ins.	Minimum diameter of branch pipe in ins.
6 in. or less, not over 1 in. thick	19	3½
7 in. to 12 in. inclusive, not over 1½ in. thick	57	4
13 in. to 16 in. inclusive, not over 2 in. thick	101	4½
17 in. to 20 in. inclusive, not over 3 in. thick	189	5
21 in. to 24 in. inclusive, not over 4 in. thick	302	5½
25 in. to 30 in. inclusive, not over 5 in. thick	472	6½

Branch pipes must not be less than the sizes specified above throughout their entire length. All branch pipes must enter the main suction duct at an angle not exceeding 45 degrees and must incline in the direction of the air flow at junction with main. Branch pipes must not project into main duct. All laps in piping must be made in the direction of the air flow. All bends, turns, or elbows, whether in main or branch pipes, must be made with a radius in the throat at least equal to one and one-half times the diameter of the pipe on which they are connected.

The inlet of the fan or exhauster shall be at least 20 per cent greater in area than the sum of the areas of all the branch pipes and such increase shall be carried proportionately throughout the entire length of the main suction duct, in other words, the area of the main at any point shall be at least 20 per cent greater than the combined areas of the branch pipes entering it between such point and the tail end or dead end of the system. If such increase is made

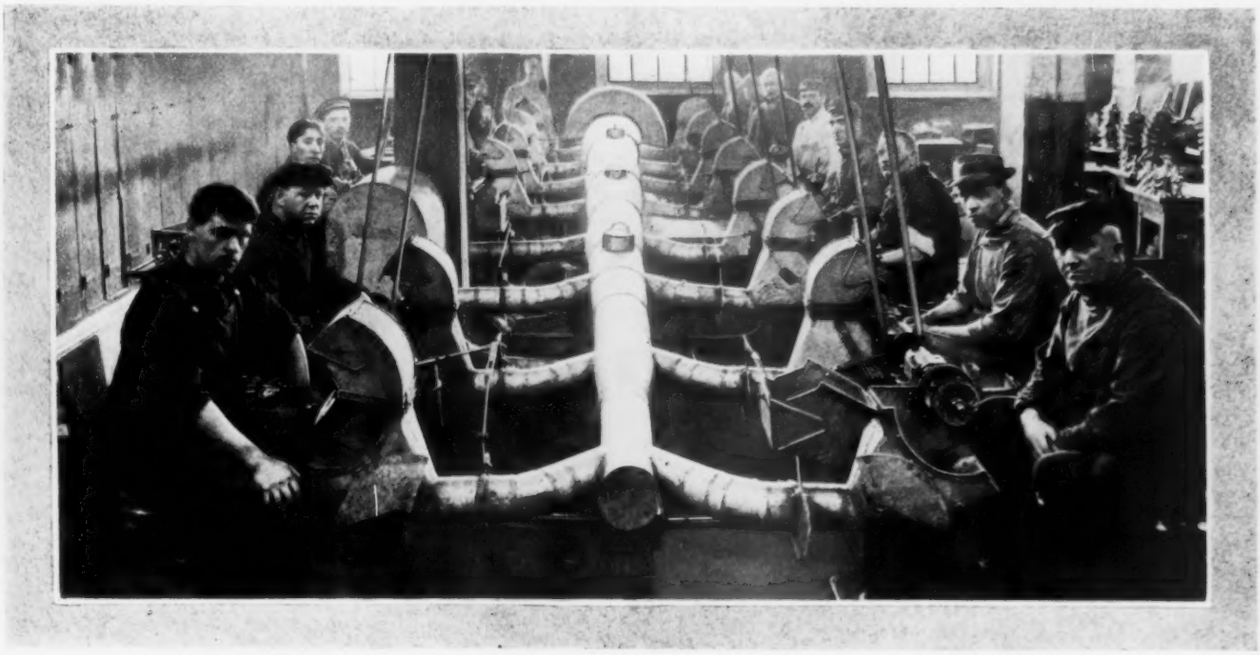


FIG. 4—PROPERLY ARRANGED DUST EXHAUST SYSTEM IN A NEW JERSEY POLISHING SHOP

FIG. 5—BUFFING BRASS WITHOUT A PROPER DUST EXHAUST SYSTEM

greater than 20 per cent, the area of the main at any point, except that portion of it between the branch entering it nearest the fan and the fan, shall bear approximately the same ratio to the combined areas of the branches preceding that point as the area of the main at the branch nearest the fan bears to the combined areas of all the branches. This provision is made to permit the use of a fan having a larger inlet area than the area of the main at the branch pipe nearest to the fan, if desired.

For the convenience of those wishing to use it, Table II shows what the size of the main suction duct should be at any point for any number of uniform-size branch pipes when the main duct is made 20 per cent greater than the combined areas of the branches entering it.

The fan outlet and the discharge pipe from the fan shall be at least 20 per cent greater in area than the sum of the areas of all branch pipes. This applies to the discharge pipe throughout its entire length. The main trunk lines, both suction and discharge, shall be provided with suitable clean-out doors not over 10 feet apart and the end of the main suction duct shall be blanked off with a removable cap placed on the end.

Sufficient static suction head shall be maintained in each branch pipe within 1 foot of the hood to produce a difference of level of 2 inches of water between the two sides of a U-shaped tube. Test is to be made by placing one end of a rubber tube over small hole made in pipe, other end of the tube being connected to one side of U-shaped water-gage. Test is to be made with all branch pipes open and unobstructed.

Plans for all exhaust system installations, showing location and sizes of all wheels, hoods, main and branch pipes, fan and dust separator should be submitted to this department in duplicate for approval before work is begun and it must be clearly specified that the system is to be installed in strict accordance with the above specifications. The test specified above positively must be obtained before the system will be acceptable to the department of labor.

The contract for the installation of an exhaust system should contain a provision to the effect that payment will be withheld until the above test shall have been made and the system accepted by the department of labor.

In addition to the above specifications, which are compulsory, a number of recommendations are given below, which, if observed, will make for still more efficient operation and longer life of the system.

Recommendations

Emery wheel and buffing wheel exhaust systems should be kept separate owing to danger of sparks from the former setting fire to the lint dust from the latter, if both are drawn into the same suction main.

In the case of undershot wheels, which is almost always the direction of rotation of both emery and buffing wheels, the main suction duct should be back of and below the wheels and as close to them as is practicable; or it should be fastened to the ceiling of the floor below, preferably the former. If behind the wheels, it should be not less than 6 inches above the floor at every point to avoid possible charring of the floor in case of fire in the main duct and also to permit sweeping under it. For similar reasons it should be at least 6 inches below any ceiling it may run under.

Both the main suction and discharge pipes should be made as short and with as few bends as possible, to avoid loss by friction. If one or the other must be of considerable length, it is best to place the fan not far beyond where the nearest branch enters the large end of the main, as a long discharge main is a lesser evil

FIG. 6—A WELL-EQUIPPED SAND BLAST ROOM

than a long suction main. Avoid any pockets or low places in ducts where dust might accumulate.

The main suction duct should be enlarged between every branch pipe entering it, whenever space permits, and in no case should the main duct receive more than two branches in a section of uniform area. All enlargements in the size of the main should be made on a taper and not by an abrupt change.

Extra Wheels

If there is a likelihood of a few additional wheels being installed in the future, it is advisable to leave a space for them between the fan and the first branch and to put in an extra size fan. Or, a space may be left beyond the fan so that the fan may be moved along and the main extended when it is actually decided to install additional wheels, provided the fan is of sufficient size to still comply with these specifications after the additional branches are added.

Branch pipes should enter the main on the top or sides—never at the bottom. Two branches should never enter a main directly opposite one another. Each branch pipe should be equipped with a shut-off damper or blast gate as it is also called, which may be closed, if desirable, when the wheel is not in use. Not more than 25 per cent of such blast gates should be closed at one time; otherwise, the air velocity in the main duct may drop too low and let the dust accumulate on the bottom. Dampers should be of the sliding type; not the stovepipe or butterfly type.

It is very important that the lower part of the hood shall come far enough forward beneath the front of the wheel so that the dust will enter the hood and not fall outside of it alogether, even if the accomplishment of this result necessitates leaving considerable space between the wheel and the lower part of the hood in order that the hood shall not interfere with the work.

Branch pipes should lead out of the hood as nearly as possible at the point where the dust will naturally be thrown into them by the wheels. This is very important. An objectionable practice sometimes found where small work is polished is the use of a screen across the mouth of the branch pipe where it enters the hood. Such screens are an obstruction to the passage of material and the ravelings from buffing wheels are held against the screen by the suction, with the result that in a short time the draught is almost entirely cut off.

The use of a trap at the junction of the hood and branch pipe is good practice provided it is cleaned out regularly and not allowed to fill up with dust. This will catch the heavier particles and so take some wear off the fan. It will also serve to catch any nuts, pieces of tripoli, etc., dropped by accident, and in the case of work on small articles, will enable them to be recovered when dropped in the hood.

All bends, turns or elbows, whether in main or branch pipes, should be made with a radius in the throat of twice the diameter of the pipe on which they are connected, wherever space permits. Elbows should be made of metal one or two gages heavier than the pipe on which they are connected as the wear on them is much greater.

The withdrawal of air from a room by an exhaust system naturally tends a create a slight vacuum and for this reason inlets for air at least equal to the sum of the areas of the branch pipes should be left open.

Recommendations for the size of the cyclone separator or dust collector, as it is often called, are hard to give, as the separator must be proportioned to suit operating conditions, light dusts requiring a larger separator than heavy dusts. It is stated, a separator should be selected the area of whose inlet is at least as large as the area of the discharge pipe from the fan. For light buffing dusts, lint, etc., the air outlet from the top of the separator should be so large that the velocity of discharge will not exceed 300 to 480 feet per minute; then select a separator of which the other dimensions are proportionate. The air outlet should be provided with a proper canopy or elbow to exclude the weather but should be otherwise unobstructed. There should be ample clearance under the separator for the accumulation or storage of the dust which should never be allowed to pile up as high as the bottom of the separator.

A drawing of an exhaust system laid out in conformity with these specifications for eight 14-inch emery wheels is furnished by the state. For eight 14-inch buffing wheels, the branch pipes would have to be not less than 4½ inches in diameter.

The state of Indiana has issued a table which shows the correct figures for diameter of pipes and speed, size and horsepower of fan required to produce an air velocity of 9,000 feet per minute under given conditions. These figures are shown in Table I. It is stated that the diameter of the fan inlet should be as large or larger than the diameter of the main suction pipe.

FIG. 7—GRINDING STEEL CASTINGS IN A DUSTLESS ROOM

Summary of Laws

Below is given a summary of the laws of all the states in this country relating to the removal of dust in grinding, cleaning, polishing or buffing operations.

ALABAMA.—None.

ARIZONA.—None.

ARKANSAS.—None.

CALIFORNIA.—"In any factory, workshop, or other establishment where a work or process is carried on by which dust, filaments, or injurious gases are produced or generated, that are liable to be inhaled by persons employed there-

in, the person, firm, or corporation, by whose authority the said work or process is carried on, shall cause to be provided and used in said factory, work-shop or other establishment, exhaust fans or blowers with pipes and hoods extending therefrom to each machine, contrivance or apparatus by which dust, filaments, or injurious gases are produced or generated.

"The said fans and blowers, and the said pipes and hoods, all to be properly fitted and adjusted, and of such power and dimensions sufficient to effectually prevent the dust, filaments, or injurious gases produced or generated by the above said machines, contrivances or apparatuses, from escaping into the atmosphere of the room or rooms of said factory, work-shop or other establishment where persons are employed."

COLORADO.—"That any person, firm, corporation or association operating a factory, mill, workshop, bakery, laundry, store, hotel, or any kind of an establishment wherein laborers are employed, or machinery used and manual labor is exercised by the way of trade for the purpose of gain within an enclosed room (private houses in which the employes live excepted) shall be provided in each workroom thereof with good sufficient ventilation and kept in a clean and sanitary state, and shall be so ventilated as to render harmless, so far as practicable, all gases, vapors, dust or other impurities, generated in the course of the manufacturing or laboring process carried on therein; and in any factory, mill, workshop, bakery, laundry, store, hotel, or any kind of an establishment wherein laborers are employed or machinery used in any enclosed rooms thereof by which dust is generated and inhaled to an injurious extent by the persons employed therein, conveyors, receptacles or exhaust fans, or other mechanical means shall be provided and maintained for the purpose of carrying off or receiving and collecting such dust."

CONNECTICUT.—"Every employer whose business requires the operation or use of any emery, tripoli, rouge, corundum, stone, carborundum, or other abrasive, polishing, or buffing wheel, in the manufacture of articles of metal or iridium, or whose business includes any process which generates an excessive amount of dust, shall install and maintain in connection therewith such devices as may be considered necessary by the factory inspector and state board of health to remove from the atmosphere any dust created by such process.

"The factory inspector, with the state board of health, shall issue to any employer engaged in such business any orders necessary to render effective the foregoing provision, and if within sixty days from the issuance of such order stating the changes to be made, such order shall not be complied with, the factory inspector may order such department closed until such order is complied with.

"The violation of any provision of the foregoing section or the failure to comply with any written order issued in accordance therewith within sixty days thereafter shall constitute a misdemeanor punishable by a fine of not more than five hundred dollars for each offense, and every such order shall be enforceable by the superior court or by a judge thereof if said court is not in session, by injunction on application of the factory inspector or of the state board of health".

DELAWARE.—Law similar to Connecticut.

FLORIDA.—None.

GEORGIA.—None.

IDAHO.—None.

ILLINOIS.—"That all persons, companies or corporations operating any factory or workshop where emery wheels or emery belts of any description are used, either solid emery, leather, leather-covered, felt, canvas, linen, paper, cotton, or wheels or belts rolled or coated with emery or corundum or cotton wheels used as buffs, shall provide the same with blowers, or similar apparatus, which shall be placed over, beside or under such wheels or belts in such a manner as to protect the person or persons using the same from the particles of dust produced and caused thereby, and to carry away the dust arising from or thrown off by such wheels or belts while in operation directly to the outside of the building or to some receptacle placed so as to receive and confine such dust.

"Provided, that grinding machines upon which water is used at the point of the grinding contact shall be exempt from the provisions of this Act, and provided, this Act shall not apply to small shops employing not more than one man in such work.

"It shall be the duty of any person, company or corporation operating any such factory or workship to provide or construct such appliances, apparatus, machinery or other things necessary to carry out the purpose of this Act, as set forth in the preceding section as follows: Each and every such wheel shall be fitted with a sheet of case iron or hood or hopper of such form and so applied to such wheel or wheels that the dust or refuse therefrom will fall from such wheels or will be thrown into such hood or hopper by centrifugal force and be carried off by the current of air into a suction pipe which is attached to same hood or hopper.

"Each and every such wheel six inches or less in diameter shall be provided with a three-inch suction pipe; wheels six inches to twenty-four inches in diameter with four-inch suction pipe; wheels from twenty-four inches to thirty-six inches in diameter with five-inch suction pipe; and all wheels larger in diameter than those stated above shall be provided each with a suction pipe not less than six inches in diameter.

"The suction pipe from each wheel, so specified, must be full size to the main trunk suction pipe and the main suction pipe to which smaller pipes are attached shall, in its diameter and capacity, be equal to the combined area of such smaller pipes attached by the same, and the discharge pipe from the exhaust fan, connected with such suction pipe or pipes, shall be as large or larger than the suction pipe.

"It shall be the duty of any person, company or corporation operating any such factory or workshop to provide the necessary fans or blowers to be connected with such pipe or pipes, as above set forth, which shall be run at a rate of speed as will produce a velocity of air in such suction or discharge pipes of at least nine thousand feet per minute to an equivalent suction or pressure of air equal to raising a column of water not less than five inches in a U-shape tube. All branch pipes must enter the main trunk pipe at an angle of forty-five degrees or less, the main suction or trunk pipe shall be below the emery or buffing wheels and as close to the same as possible, and to be either upon the floor or beneath the floor on which the machines are placed to which such wheels are attached. All bends, turns or elbows in such pipes must be made with easy, smooth surfaces, having a radius in the throat of not less than two diameters of the pipe on which they are connected.

"Any such person or persons or company, or managers, or directors of any such company or corporation who shall have the charge or management of such factory or workshop, who shall fail to comply with the provisions of this Act, shall be deemed guilty of a misdemeanor, and upon conviction thereof before any court of competent jurisdiction, shall be punished by a fine of not less than $25 and not exceeding $100."

The Illinois law also contains the following provision: "All factories, mercantile establishments mills or workshops shall be kept free from gas of effluvia arising from any sewer, drain, privy or other nuisance on the premises. All poisonous and noxious fumes or gases arising from any process, and all dust of a character injurious to the health of the persons employed, which is created in the course of a manufacturing process, within such factory, mill or workship, shall be removed, as far as practicable, by either ventilating or exhaust devices."

INDIANA.—"Exhaust fans of sufficient power shall be provided for the purpose of carrying off dust from emery wheels and grindstones and dust-creating machinery from establishments where used."

IOWA.—"All persons, companies or corporations operating any factory or workshop where emery wheels or emery belts of any description, or tumbling barrels used for rumbling or polishing castings, are used, shall provide the same with blowers and pipes of sufficient capacity, placed in such a manner as to protect the person or persons using same from the particles of dust produced or caused thereby, and to carry away said particles of dust arising from or thrown off such wheels, belts or tumbling barrels while in operation, directly to the outside of the building, or to some receptacle placed so as to receive or

Table I.

SIZES OF PIPES AND FANS FOR DUST EXHAUST SYSTEM

Indiana Law.

No. branch pipes.	Branch pipe 3 in. diameter.	Branch pipe 4 in. diameter.	Branch pipe 5 in. diameter.	Branch pipe 6 in. diameter.	Diameter of fan inlet.	Size of fan.	Rev. per minute.
	Main, in.	Main, in.	Main, in.	Main, in.			
2	5	6	7	9	6	1	2,460
4	6	8	10	12	8	2	2,150
6	8	10	13	15	10	25	1,920
8	9	12	14	17	12	30	1,820
10	10	13	16	19	14	35	1,565
12	11	14	17	21	15	40	1,380
14	12	15	19	23	17	45	1,230
16	12	16	20	24	19	50	1,080
18	13	17	21	26	21	55	985
20	14	18	22	27	23	60	905
22	14	19	24	29	25	65	860
24	15	20	25	30	31	70	785
26	16	21	26	31	37	80	700
28	16	21	27	32			
30	17	22	27	33			
32	17	23	29	34			
34	18	23	29	35			
36	18	24	30	36			
38	19	25	31	37			
40	19	26	32				

confine such particles or dust; provided, however, that grinding machines upon which water is used at the point of grinding contact, and small emery wheels which are used temporarily for tool grinding, are not included within the provisions of this section, and the shops employing not more than one man at such work may, in the discretion of the commissioner of the bureau of labor of the state, be exempt from the provisions hereof. Any factory, workshop, print-shop or other place where molten metal or other material which gives off deleterious gases or fumes is kept or used shall be equipped with pipes or flues so arranged as to give easy escape to such gases or fumes into the open air, or provided with other adequate ventilators."

KANSAS.—No specific law on the subject, but state factory inspectors are empowered to order dust exhaust apparatus wherever it seems necessary to protect the health and comfort of employes.

KENTUCKY.—None.

LOUISIANA.—None.

MAINE.—No specific legislation.

MARYLAND.—No specific legislation.

MASSACHUSETTS.—"If, in a workshop, or factory any process is carried on by which dust is caused which may be inhaled to an injurious extent by the persons employed therein, and it appears to an inspector of the state board of labor and industries that such inhalation would be substantially diminished without unreasonable expense by the use of a fan or by other mechanical means, such fan or other mechanical means, if he so direct, shall be provided, maintained and used.

"A criminal prosecution shall not be instituted for any violation of the provisions of the two preceding sections unless such employer neglects, for four weeks after the receipt of a notice in writing, to make such changes in his factory or workshop as shall be ordered by an inspector of the state board of labor and industries.

"Any person, firm or corporation operating a factory or workshop in which emery wheels or belts or buffing wheels or belts injurious to the health of employes are used shall provide such wheels and belts with a hood or hopper connected with suction pipes, and with fans or blowers, in accordance with the provisions hereinafter contained, which apparatus shall be so placed and operated as to protect any person using such wheel or belt from the particles or dust produced by its operation, and to convey the particles or dust either outside of the building or to some receptacle so placed as to receive and confine such particles or dust.

"Every such wheel shall be fitted with a sheet iron or cast iron hood or hopper of such form and so placed that the particles or dust produced by the operation of the wheel or of any belt connected therewith shall fall or will be thrown into such hood or hopper by centrifugal force; and the fans or blowers shall be of such size and shall be run at such speed as will produce a volume and velocity of air in the suction and discharge pipes sufficient effectually to convey all particles or dust from the hood or hopper through the suction pipes and so outside of the building or to a receptacle as aforesaid. The suction pipes and connections shall be suitable and efficacious, and such as shall be approved by an inspector of the state board of labor and industries.

"The two preceding sections shall not apply to grinding machines upon which water is used at the point of grinding contact, nor to solid emery wheels used in saw mills, or in planing mills or in other wood working establishments, nor to any emery wheel six inches or less in diameter used in establishments where the principal business is not emery wheel grinding.

"Whoever fails to comply with any provision of the preceding sections shall, for the first offence be punished by a fine of not less than $25 nor more than $100, and, for a second offence he shall be punished by the fine aforesaid or by imprisonment in jail for not more than sixty days, or by both fine and imprisonment."

MICHIGAN.—Law provides for the installation of dust exhaust where necessary and is similar in its general nature to the Ohio statute.

MINNESOTA.—No specific legislation.

MISSISSIPPI.—None.

MISSOURI.—"Every person, firm or corporation using any polishing wheel or machine of any character which generates dust, smoke or poisonous gases in its operation, shall provide each and every such wheel or machine with a hood, which shall be connected with a blower or suction fan of sufficient power to carry off said dust, smoke and gases and prevent its inhalation by those employed about said wheel or machine; and any violation of this section is hereby declared to be a misdemeanor, and a person, firm or corporation so violating this section shall, upon conviction, be punished by a fine of not less than one hundred dollars nor more than five hundred dollars for each and every offense. It shall be the duty of the factory inspector and his deputies to see that this section is enforced and to prosecute any violations thereof.

"In all establishments in this state wherein labor is employed, where any process is carried on by which dust or smoke is generated the factory inspector and his deputies shall have the power and the authority to order that a fan or some other contrivance be put in to prevent the inhalation of such dust or smoke by employes."

MONTANA.—None.

NEBRASKA.—"If in any of the aforesaid places, any process is carried on, by which dust or fumes is caused, which may be inhaled by the persons employed therein, or if the air should become exhausted or impure, there shall be provided a fan or other such mechanical device as will substantially carry away all such dust or fumes or other impurities, subject to the approval of the commissioner of labor, his deputies or factory inspectors.

"All persons, companies or corporations operating any factory or work-shop where grinding wheels, or grinding machines, emery wheels or emery belts of any description are used either solid emery, leather covered, felt canvas, linen, paper, cotton, or wheels or belts rolled or coated with emery or carborundum or cotton wheels used as buffs, shall, when deemed necessary, by the labor commissioner, his deputy or any factory inspector, provide such wheels or belts with blowers or similar apparatus, which shall be placed over, beside or under such wheels or belts in such manner as to protect the person or persons using the same from the particles of the dust produced and caused thereby, and to carry away the dust arising from or thrown off by such wheels or belt while in operation directly to the outside of the building or to some receptacle placed so as to receive and confine such dust; Provided, that grinding machines upon which water is used at the point of grinding contact and other wheels used for tool grinding shall be exempt from the provisions of this act."

NEVADA.—None.

NEW HAMPSHIRE.—None.

NEW JERSEY.—Law and specifications substantially the same as in Ohio.

NEW MEXICO.—None.

NEW YORK.—"All grinding polishing or buffing wheels used in the course of the manufacture of articles of the baser metals shall be equipped with proper hoods and pipes and such pipes shall be connected to an exhaust fan of sufficient capacity and power to remove all matter thrown off such wheels in the course of their use. Such fan shall be kept running constantly while such grinding, polishing or buffing wheels are in operation; except that in case of wet-grinding it is unnecessary to comply with this provision unless

Table II.

AREA OF PIPES SPECIFIED BY NEW YORK LAW

Number of branch pipes	Diameter of Branch Pipes in inches: 3	3½	4	4½	5	5½	6	6½	7
	Area of each Branch Pipe in square inches. 7.07	9.62	12.566	15.9	19.635	23.758	28.274	33.183	38.485
	Area of each Branch Pipe plus 20 per cent (square inches). 8.484	11.544	15.08	19.08	23.562	28.51	33.93	39.82	46.182
1	3 3/16	3 7/8	4 3/8	5	5 1/2	6	6 5/8	7 1/8	7 3/4
2	4 1/4	5 1/2	6 1/4	7	7 3/4	8 5/8	9 1/4	10 1/8	10 7/8
3	5 3/4	6 5/8	7 5/8	8 5/8	9 1/2	10 1/2	11 1/2	12 3/8	13 1/4
4	6 5/8	7 3/4	8 3/4	9 7/8	11	12 1/8	13 1/8	14 1/4	15 3/8
5	7 3/8	8 5/8	9 7/8	11	12 1/4	13 1/2	14 3/4	16	17 1/8
6	8 1/8	9 1/2	10 3/4	12 1/8	13 1/2	14 3/4	16 1/8	17 1/2	18 3/4
7	8 3/4	10 1/4	11 5/8	13 1/8	14 1/2	16	17 1/2	18 7/8	20 1/4
8	9 3/8	10 7/8	12 3/8	14	15 1/2	17 1/8	18 5/8	20 1/8	21 3/4
9	9 7/8	11 1/2	13 1/8	14 7/8	16 1/2	18 1/8	19 3/4	21 3/8	23
10	10 1/2	12 1/8	13 7/8	15 5/8	17 3/8	19 1/8	20 3/4	22 1/2	24 1/4
11	11	12 3/4	14 5/8	16 3/8	18 1/4	20	21 7/8	23 5/8	25 1/2
12	11 1/2	13 3/8	15 1/2	17 1/8	19	20 7/8	22 3/4	24 3/4	26 5/8
13	11 7/8	13 7/8	15 7/8	17 7/8	19 3/4	21 3/4	23 3/4	25 3/4	27 3/4
14	12 3/8	14 3/8	16 1/2	18 1/2	20 1/2	22 5/8	24 5/8	26 3/4	28 3/4
15	12 3/4	14 7/8	17	19 1/8	21 1/4	23 3/8	25 1/2	27 5/8	29 3/4
16	13 1/4	15 3/8	17 5/8	19 3/4	22	24 1/8	26 3/8	28 1/2	30 3/4
17	13 5/8	15 7/8	18 1/8	20 3/8	22 5/8	24 7/8	27 1/8	29 3/8	31 5/8
18	14	16 3/8	18 5/8	21	23 1/4	25 5/8	27 3/8	30 1/4	32 5/8
19	14 3/8	16 3/4	19 1/8	21 1/2	23 7/8	26 1/4	28 3/4	31 1/8	33 1/2
20	14 3/4	17 1/8	19 5/8	22 1/8	24 1/2	27	29 1/2	31 7/8	34 3/8
21	15 1/8	17 5/8	20 1/8	22 5/8	25 1/8	27 5/8	30 1/8	32 3/4	35 1/8
22	15 1/2	18	20 5/8	23 1/8	25 3/4	28 3/8	30 7/8	33 1/2	36
23	15 3/4	18 1/2	21 1/8	23 3/4	26 3/8	29	31 1/2	34 1/4	36 3/4
24	16 1/8	18 7/8	21 1/2	24 1/4	26 7/8	29 5/8	32 1/4	34 7/8	37 5/8
25	16 1/2	19 1/4	22	24 3/4	27 1/2	30 1/8	32 7/8	35 5/8	38 3/8
26	16 3/4	19 5/8	22 3/8	25 1/8	28	30 3/4	33 1/2	36 3/8	39 1/8
27	17 1/8	20	22 7/8	25 5/8	28 1/2	31 3/8	34 1/8	37	39 7/8
28	17 1/2	20 3/8	23 1/4	26 1/8	29	32	34 3/4	37 3/4	40 5/8
29	17 3/4	20 3/4	23 5/8	26 5/8	29 1/2	32 1/2	35 1/2	38 3/8	41 3/8
30	18	21	24	27	30	33	36	39	42

required by the rules and regulations of the industrial board. All machinery creating dust or impurities shall be equipped with proper hoods and pipes and such pipes shall be connected to an exhaust fan of sufficient capacity and power to remove such dust or impurities; such fan shall be kept running constantly while such machinery is in use; except where, in case of wood-working machinery, the industrial board shall decide that it is unnecessary for the health and welfare of the operatives."—New York has also issued a set of standard specifications for dust removal apparatus which are published elsewhere in this article.

NORTH CAROLINA.—None.

NORTH DAKOTA.—None.

OHIO.—"They shall provide emery wheels or belts of solid emery, leather covered, felt, canvas, linen, paper, cotton or wheels or belts, rolled or coated with emery or corundum, or cotton wheels used as buffs, with blowers or similar apparatus placed over, beside or under such wheels or belts in such a manner as to protect the person or persons using them from particles or dust produced and caused thereby. They shall provide each emery wheel with a sheet or cast iron hood or hopper of such form and so applied to it that the dust or refuse therefrom will fall from such wheels or will be thrown into such hood or hopper by centrifugal force and be carried off by the current of air into a suction pipe attached to such hood or hopper.

"They shall provide an emery wheel six inches or less in diameter with a three inch suction pipe, an emery wheel six inches to twenty-four inches in diameter with a four inch suction pipe; an emery wheel twenty-four inches to thirty-six inches in diameter with a five inch suction pipe and every emery wheel larger than those provided for with a suction pipe not less than six inches in diameter. Such suction pipe shall be full sized to the main trunk suction pipe, and the main suction pipe to which smaller pipes are attached shall be equal in its diameter and capacity to the combined area of the smaller pipes attached to it. The discharge pipe from the exhaust fan connected with pipe or pipes shall be as large or larger than the suction pipe.

"They shall provide necessary fans or blowers connected with suction pipes, which shall be run at a rate of speed sufficient to produce a velocity of air in such suction or discharge pipes of at least nine thousand feet per minute to an equivalent suction or pressure of air equal to raising a volume of water not less than five inches in a U-shaped tube. All branch suction pipes must enter the main pipe at an angle of forty-five degrees or less; the main suction or trunk pipe shall be below the emery or buffing wheels and as close to them as possible and be either upon the floor or beneath the floor on which the machinery to which such wheels are attached are placed. All bends, turns or elbows in such suction pipes must be made with easy smooth surfaces having a radius in the throat of not less than two diameters of the pipe on which they are connected.

"Nothing in this section regarding blowers, hoods, hoppers, or suction pipes shall apply to emery wheels upon which water is used at the point of the grinding contact, nor shall emery wheels used temporarily for tool grinding or small shops employing not more than one man at work upon an emery wheel, which does not create dust enough in the opinion of the chief inspector of workshops and factories or a district inspector to be injurious to its operator. No female shall be employed in operating, assisting to operate, or using any of the wheels or belts specified in the preceding four subdivisions of this section.

"Whoever, being a person, firm or corporation, fails to comply with any provision of the preceding section, or fails to comply with such orders for changes as are issued by the chief inspector, within thirty days thereafter shall be fined not less than one hundred dollars nor more than three hundred dollars for each offense. All fines collected under this section shall inure to the benefit of the county hospital for tuberculosis. In prosecution for violations of this section by or under the direction of the chief inspector, such inspector shall not be required to give security for costs or adjudged to pay any costs. In cases where the accused is acquitted, the costs shall be paid from the treasury of the county in which such proceedings were brought."

OKLAHOMA.—No specific legislation.

OREGON.—No specific legislation.

PENNSYLVANIA.—"Be it enacted, &c., That all persons, companies, or corporations operating any factory or workshop where emery-wheels or emery-belts of any description are used, either solid emery, leather, leather-covered, felt, canvas, linen, paper, cotton, or wheels or belts rolled or coated with emery or corundum, or cotton-wheels used as buffs, shall provide the same with blowers, or similar apparatus, which shall be placed over, beside, or under such wheels or belts, in such a manner as to protect the person or persons using the same from the particles of dust produced and caused thereby, and to carry away the dust arising from or thrown off by such wheels or belts, while in operation, directly to the outside of the building, or to some receptacle placed so as to receive and confine such dust: Provided, That grinding machines upon which water is used at the point of the grinding contact shall be exempt from the provisions of this act; and, provided, this act shall not apply to factories or workshops where men are not employed continuously at such wheels or belts more than three hours in twenty-four.

"It shall be the duty of any person, company, or corporation operating any such factory or workshop to provide or construct such appliances, apparatus, machinery, or other things necessary to carry out the purpose of this act, as set forth in the preceding section, as follows: Each and every wheel shall be fitted with a sheet of cast iron, or hood or hopper, of such form, and so applied to such wheel or wheels, that the dust or refuse therefrom will fall from such wheels, or will be thrown into such hood or hopper by centrifugal force, and be carried off by the current of air into a suction-pipe attached to same hood or hopper.

"This act shall become operative on the first day of January, 1914.

"The inspectors of the Department of Labor and Industry are hereby authorized to enter and inspect all factories and workshops, for the purpose of enforcing the provisions of this act.

Any person or persons, or company, or managers or directors of any company or corporation, who shall have the charge or management of any factory or workshop, who shall fail to comply with the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not less than one hundred dollars and not exceeding three hundred dollars. All acts or parts of acts inconsistent with the provisions of this act are hereby repealed."

RHODE ISLAND.—No specific legislation.

SOUTH CAROLINA.—None.

SOUTH DAKOTA.—None.

TENNESSEE.—No specific legislation.

TEXAS.—None.

UTAH.—None.

VERMONT.—None.

VIRGINIA.—None.

WASHINGTON.—"Every factory, mill or workshop where machinery is used, and manual labor is exercised by the way of trade for the purposes of gain within an enclosed room (private houses in which the employes live, excepted) shall be provided in each work room thereof with good and sufficient ventilation and kept in a cleanly and sanitary state, and shall be so ventilated as to render harmless, so far as practicable, all gases, vapors, dust or other impurities, generated in the course of the manufacturing or laboring process carried on therein; and if in any factory, mill or workshop any process is carried on in any enclosed room thereof, by which dust is generated and inhaled to an injurious extent by the persons employed therein, conveyors, receptacles or exhaust fans, or other mechanical means, shall be provided and maintained for the purpose of carrying off or receiving and collecting such dust."

WEST VIRGINIA.—No specific legislation.

WISCONSIN.—"All grinding, buffing and polishing wheels, except wheels where water is applied at point of grinding, must be equipped with a hood. The hood must cover the wheel in such manner that it will carry off the dust insofar as the character of the work will permit. On grinding, buffing or polishing wheels 4 inches or less in width, the width of hood must be 6 inches. On grinding, buffing or polishing wheels over 4 inches in width the maximum width of hood must never be less than 2 inches nor more than 3 inches wider than the width of the wheel. The wheel must be measured across the face,

"The size of the suction pipe on hoods for grinding, buffing or polishing wheels must be as follows:

DIAMETER OF WHEEL.

6 inches to 10 inches,
10 inches to 18 inches,
18 inches to 24 inches,
Over 24 inches.

DIAMETER OF SUCTION PIPE.

3 inches to 4 inches,
4 inches to 5 inches,
5 inches to 6 inches,
6 inches.

"Where two sizes of pipe are specified above, the smaller size will not be permitted except in cases where the hood covers two-thirds of the wheel or where the work to be done is so light that the dust is easily exhausted.

"On all grinding, buffing and polishing wheels, the suction in the connection to the hood must be sufficient to displace a column of water in a U tube 5 inches. The test for suction with the U tube must be a static test and must be made in the following manner: A hole ⅛-inch in diameter must be made in the suction pipe approximately 12 inches from the connection to the hood. The rubber hose attached to the U tube must be placed over the ⅛-inch hole and the test made under these conditions. When the water in the U tube stands at 0, the 5-inch displacement is secured when one column of water rises 2½ inches above 0 and the other column of water falls 2½ inches below 0.

"All branch suction pipes must enter the main pipe in the direction of the flow of air and at an angle not exceeding 45 degrees, measured from a line drawn parallel with the current of air in the main suction pipe. On all grinding, buffing or polishing wheels, the main suction or trunk pipe must be placed below and as close to the wheels as possible, either on the floor or beneath the floor on which the machines are located. All bends, turns and elbows in suction and discharge

pipes must be made with smooth interior surfaces and the radius of the curvature of the elbows on such pipes, measured from the center of the pipe, must not be less than twice the diameter of such elbows.

"The dust discharged from any exhaust system must be taken care of by a dust collector, air washer or other adequate system which will prevent it from contaminating the air in or around the place of employment.

"All belts, drums, rolls or disks, used for grinding, buffing, polishing or sanding, must be equipped with an exhaust system so designed and attached that it will carry off the dust insofar as the character of the work will permit.

"All sand blasting operations, not performed under an enclosed hood, must be performed in a special room set aside for that purpose. This room must be equipped with an exhaust system which shall change the air in the room not less than 4 times per minute. The employer must furnish the employes who are working in sand blast rooms with a suitable covering for the face, which will protect the eyes, nose and mouth; such protector should be worn by the employe when working in the sand blast room.

"All tumbling barrels and rattlers must be equipped with an exhaust system, which will remove all particles of dust which are light enough to float in the air. All machines which create and throw off dust sufficiently light to float in the air, must be equipped with an exhaust system so designed and attached that it will carry off the dust insofar as the character of the work will permit."

WYOMING.—None.

How to Use Plaster of Paris

By D. Gordon

To mix plaster of Paris, sprinkle it into the desired amount of water until it settles, as a powder, upon the water surface. Stir quickly, by hand, until it attains the consistency of cream when it is ready for use.

To retard the quick-setting action of plaster, place lime into the water previous to mixing the plaster, the amount being judged by clouding the water.

To give a parting between one body of plaster and another, the plaster of the first made portion at the position where the joint or parting is required should be coated with any light oil, such as machine or olive oil.

Previous to oiling, for parting or jointing purposes, it is advisable to first give a coating of varnish, preferably shellac. This prevents the plaster from absorbing the oil.

Oil should be applied in a fine film; if in excess, it is liable to cause blowholes and sharp corners to lose their definition.

Another method of parting is to insert a thin plate (22 gage) of tin or zinc between the surfaces required to be parted. This method is usually adopted in cases where small, loose pieces are necessary.

To make further additions of plaster, as for making up bosses or facings, slightly roughen the set surface where the addition is necessary, run on the amount required and allow it to set.

To repair a plaster fracture, give the fractured joints a heavy coating of thick shellac varnish and allow to thoroughly dry before handling.

If conveniently possible, reinforce the patterns with roughly bent wire permeating the job in all directions, but as one unit. This applies also to plaster core boxes, but wire mesh is preferable to wires.

In core boxes, insert at those positions where rapping will take place for loosening the core, pieces of roughly cut wood into the plaster before the latter has hard-set. The wood absorbs and distributes the jarring forces throughout the box without fractures occurring, owing to its resiliency, which is greater than that of plaster.

All plaster patterns should be molded upon their pattern blocks to prevent fractures due to unequal ramming of the sand.

For pattern blocks, use coarse grade plaster for bedding purposes, with *fine* for surfaces. This method is more economical, but equally as efficient as using all *fine*.

For heavy work further economies may be practiced by bedding-up the work with broken coke and sand.

Superfine plaster is generally an unnecessary luxury for patternmaking.

Fuel Ratio on Car Wheel Iron

By W. J. Keep

Question:—What size coke bed is required in a cupola 48 inches in diameter with 480 square inches of tuyere area, the blast being delivered through a 17-inch pipe from a positive pressure blower? The wind gage shows an average of 10 ounces of blast. The tuyeres are located 14 inches above the sand bottom of the cupola. Also what would be the proper amount of coke and iron for the succeeding 15 or 20 charges after the bed? On heats averaging 20 tons, what ratio of fuel to iron should be obtained? We are using a good grade of Virginia coke with ash running lower than 6 per cent, high carbon and low sulphur and we are melting a low silicon iron averaging 1 per cent, with low phosphorus, using as high as 20 to 30 per cent steel. Some foundrymen contend that steel and low silicon or white iron melts at lower temperature than iron containing higher silicon. While this may be true in a sense, it has been the writer's experience that iron of this character must be heated to a higher temperature for handling and therefore it is necessary to apply more heat than will be required for melting a softer iron. I believe that foundrymen generally are using a larger amount of coke to melt this class of iron than for melting a softer iron, or in other words, are using a greater amount of coke in proportion. What is your opinion on this subject? As we are manufacturers of car wheels we also have had chill cracks immediately after installing new chills, but after they were used about ten days this trouble ceased. There has been a difference of opinion among our executive force as to the cause of this trouble. However, we were not successful in eliminating this difficulty altogether.

Answer:—Your cupola melting conditions are ideal. In the first place, the amount of coke placed on the bed of the cupola must be determined by measure. After the wood has burned out and the bed is well kindled, enough coke should be added to bring the surface 15 inches above the top of the tuyeres; then add the first charge of iron. By weighing-out a quantity of coke on the scaffold and weighing what is left you can approximate what is needed for the bed. By using a little more coke than this you never will have dull iron at the start. If you catch your iron in a large ladle, you can use quite large iron charges. However, if you employ small bull ladles, you had better use one-ton charges. The charge on the bed generally can be 50 per cent greater than the rest of the charges. You can increase the iron on the first charge so long as the melted iron is hot enough for your use. The coke should cover the iron on each charge and this will take about one-tenth as much coke as iron for each charge. Beginning with this you can add 25 pounds of iron to each charge as long as the iron is hot enough, or if you choose, leave the iron at 2000 pounds and reduce the coke charges 10 pounds until you are compelled to stop. For car wheels you can melt at a ratio of 10:1 or even better with a 20-ton heat. A low silicon pig iron melts at a lower temperature than one containing a high percentage of silicon. However, the iron is not so fluid and it freezes so quickly that it is necessary to heat it as hot as iron containing more silicon. A cupola is not adapted to melting steel scrap alone as the iron would freeze before you could get it into the ladle. By using pig iron with steel scrap you can employ from 10 to 30 per cent of steel and in any event, you must melt the iron very hot. For car wheels you do not have the alternative to use an iron with higher silicon even if it can be melted with less fuel. The chill, shrinkage and strength are the first considerations. A little more or less fuel is of minor importance.

The chilling problem is a complicated one. Much depends on the composition of the iron used in the chills and also on the surface of the chill. After use, the

surface will absorb heat faster and the heat will expand the chill more quickly so that the surface of the wheel will not remain so long in contact with the chill. The chilling of the wheel is instantaneous because the wheel shrinks immediately and the chill expands at once, separation being greater the longer the chill and the wheel lie in the mold. Therefore, as soon as the wheel can be moved, remove the chill and place the wheel into the soaking pit to prevent cracks in the chill surface. There is a perceptible expansion in the central, gray portions of the wheel just as it loses its red color and if the wheel can be placed into the pit before this takes place, chill cracks which show will not occur. To make a good car wheel from coke pig iron with steel scrap and high sulphur is quite an accomplishment and is considered a chemist's job.

Shot in Gray Iron

By W. M. Carr

My observations on the cause of shot in gray iron is that their existence cannot be accounted for by chemical analysis. Were this phenomena the result of an exudation of an eutectic into a cavity, a higher percentage of phosphorus than the matrix or body surrounding the shot should identify them, but in the absence of an excess of phosphorus another cause must be sought.

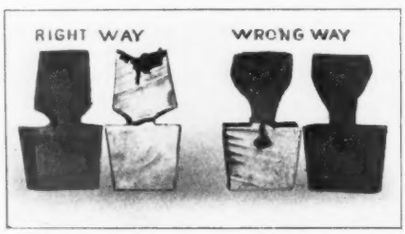
The fact that shot may prove to be highly carbonized with a lowered content of silicon does not disclose its presence as a eutectic. Assuming, however, that it may be the latter, why should a cavity be filled with one shot and that cavity snugly fit around it? If the shot was exuded would it not be a nexus? Or if an exudation, should not the walls of the cavity be pimpled not unlike the surface of a golf ball in miniature? The fact that the nexus is absent and that the walls of the cavity or cavities are smooth, reproducing in intaglio any irregularities on the surface of the shot, suggests very strongly that shot in iron castings are caused by splashes of metal when pouring through a deep gate. That is, the first portion of the stream of hot metal falling from a height and striking the bottom of the gate splits up in the first effect into numerous globules which bounce or rebound and roll away some distance ahead of the stream. In so doing they chill enough to solidify and in rolling on the bottom of the mold take up the carbonaceous facing; subsequently, the metal gradually filling the mold, is not hot enough to remelt the scattered globules. Remelting might be delayed by a coating of graphite on their surface. Since some observers have found an excess of carbon we here have an apparent explanation of that gain, which in turn accounts for the lessened percentage of silicon by dilution. Consequently, that which appears to be extruded shot on the fractured surfaces of heavy castings is nothing less than floated, chilled splashes of metal.

Commendable Action

An incident of more than passing interest has recently occurred at the foundry of the Commonwealth Steel Co., Granite City, Ill. We quote from the International Molders' Journal:

Last summer some changes were made in the rigging of certain jobs, and at the time the company agreed to share half of the time saved through the new equipment with the molders.

In November the company notified the molders that a saving of several hundred dollars had been made, and that half of the amount would be given to the molders, requesting them to determine how this, their half, should be distributed among them.



CASTINGS WHICH SHOW RIGHT AND WRONG WAY OF CUTTING HEADS IN STEEL FOUNDRY WORK

Business had been dull for some time and a number of the molders employed by the firm had been idle. The molders were aware that the company had been giving assistance to their idle molders from a fund it had set aside for this purpose. It was decided to notify the company that the molders preferred to have the money coming to them from the saving of time which had been made turned into this fund.

The company accepted the proposition, and in reply notified the molders that they would place the other half into the same fund. The action of the company and that taken by the molders is exceptional, and indicates a spirit unfortunately too rare between employers and workmen.

Where such relations exist, it is not difficult to adjust the questions which arise between a firm and the workmen in its employ. The company and the molders in their employ have set a splendid example of practical helpfulness in the manner in which time saved has been devoted to the assistance of unemployed molders who were on the firm's pay roll at the time that dullness in trade had thrown them out of employment.

Educating Steel Foundry Molders

At the plant of the Sivyer Steel Casting Co., Milwaukee, efforts are being made to educate the molders in the proper method of gating and arranging heads for steel castings. From experience, the executives of this shop have found that the average steel molder learns his trade in a gray iron foundry and that it is almost impossible to teach him the proper method of heading. To impress upon the molders the proper method of doing this work, sample heads have been prepared and are prominently displayed in the shops, being labeled "The Right Way" and "The Wrong Way", as shown in the accompanying illustration. The head labeled "The Right Way" shows a casting cut through the center and contains no shrinkage below the head, which occurs in the casting labeled "The Wrong Way". The amount of waste metal, or in other words, the head in the casting labeled "The Wrong Way", is the same as that contained in the one labeled "The Right Way". However, the casting labeled "The Wrong Way" is a good illustration of the way a molder trained in a gray iron shop will cut heads.

Clarage Fan Co.

The firm name of the Clarage Foundry & Mfg. Co., Kalamazoo, Mich., has been changed to the Clarage Fan Co. Owing to the continued growth of this company's fan business and because this line has been developed until the company is now in position to take care of fan requirements in any field it was decided to change the name so that it is more indicative of the business in which the company is engaged. A large number of the fans manufactured by the Clarage company have been used in connection with stoker installations where the requirements call for comparatively high pressures, with continuous operation of vital importance and where the outfits frequently were installed in dusty locations. The fans manufactured by this company are rigidly braced and exceedingly heavy. The men connected with the company have had a wide experience in the building of fans, some of them having been engaged in this line of work for a period of 30 years.

The Linde Air Products Co., New York City, has established a warehouse at 104 North Fifth street, Portland, Ore.

Operating a Foundry on a Scientific Basis---IV

This Installment Discusses the Important Function of Standard Elemental Sub-Operations

By Frederic A Parkhurst

REFERENCE has been made in the foregoing articles to standard elemental operations; these are more correctly described as standard elemental sub-operations as they are really sub-operations, combinations of which form "operations". The method of procedure in taking standard elemental times is the same as described above in considerable detail and as there stated, this description applies to all types of time study work. It is essential that before much general time study work is undertaken, we determine these standard elemental times.

Table III is given as representative of the more important standard elemental operations for foundry work. It will be noticed that the table is divided into two classes. One class includes those times which are influenced almost solely by the size or weight of the flask used. The other class representing those operations which are more or less dependent on the kind of equipment or method in use. In the first class a different time will be realized for each sub-elemental operation for each flask in use. In the second class, the same is true for each sub-elemental operation for each flask in use, except that there is the additional factor that the same combination may be used in any one of the five or six methods, namely:

Bench Molding (Hand and Machine)
Floor Molding
Hand rollover machines
Power rollover machines
Stripping plate machines
Jar ramming machines
Other methods may come into future use

Everything depends on the accuracy of the sub-elemental operation times. Obviously unusual care must be made in the selection and arrangement of equipment, as well as in recording conditions. Likewise, the operative that is being timed must be of the right capacity, and qualifications, both physical and mental. In this connection, take the average times of at least five different men or groups of men of the qualifications above described in the earlier part of these instructions.

All of the standard elemental sub-operations listed below should be timed at least 20 different times for each different condition and with each of the five average may be made. In some cases it will be desirable and practicable to take a great many more than 20 observations (under each varying condition), especially on short sub-operations. Where reference is made to taking 20 observations, it does not mean a total of 20 where you are using five different men, but 20 observations for each of the five or more men. On this kind of work accuracy is everything, for times once determined for a given condition, cannot be changed. As previously stated, they constitute a large percentage of future time determinations.

Standard Sub-Elemental Times for Bench and Squeezer Work

In Table III will be found a long list of variables for floor work, on which standard times apply. A similar list of standard sub-elemental operations has also been worked up applicable to bench and squeezer work. There are about 31 of these elemental sub-operations, for all of which standard times have been determined for various classes of work.

The variables to be provided for in establishing these standard times have been brought down to a definite standard. They consist of the following:—

Job Classes.
  1—Non cored work.
  2—Cored work.
Pattern Equipment.
  Single.
  Gated.
  Plated.
Methods.
  Bench (All hand methods).
  Machine (Power and hand Squeezer).
Flasks.
  Snap and solid flasks—15 different sizes by plane dimensions and 5 depths for each —75 combinations in all.

The following will help to describe

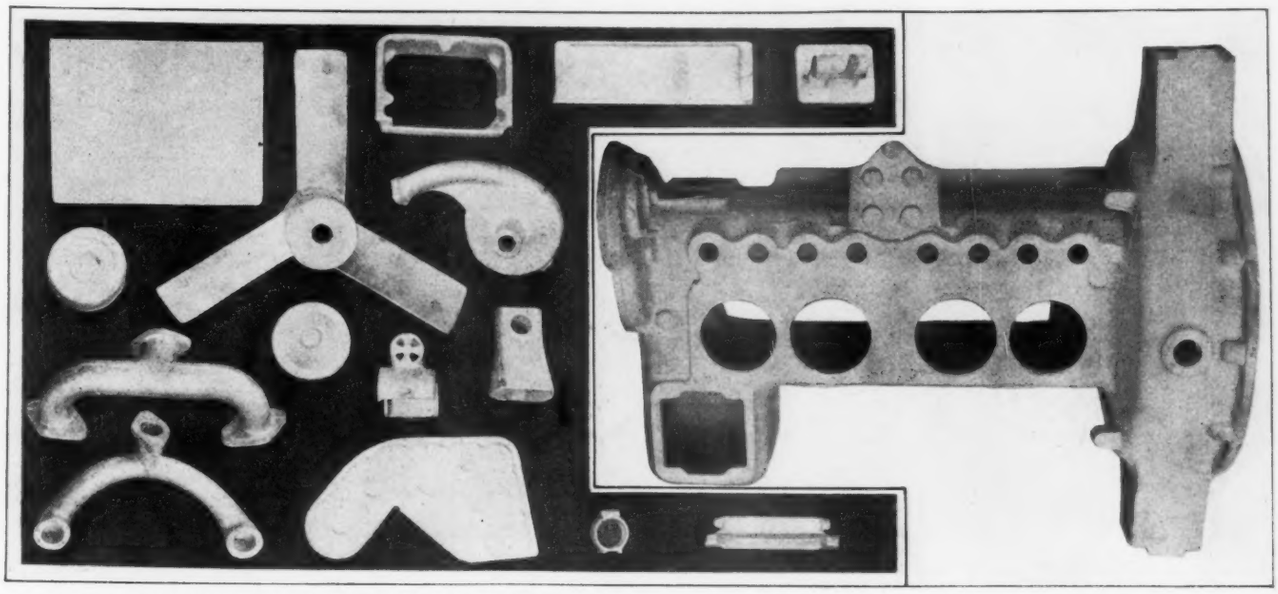


FIG. 8—SAMPLES OF WORK THAT HAS BEEN STANDARDIZED

FIG. 9—FOUR-CYLINDER CRANK CASE JOB RUN ON FLOOR AT A COST OF $1.20 PER GOOD CASTING

A paper presented at the joint session of the American Foundrymen's Association and the American Institute of Metals, Chicago, Sept. 9, 1914.

more fully the sub-divisions of the above job classes. It may be mentioned here that plated patterns come in the same "job class" as gated work. See Fig. 8, which illustrates a few of the many varieties of work which has been standardized.

Job Class 1 Non-Cored Work.
- 1a. Plain—single pattern.
- 1b. Plain—gated pattern.
- 1c. Irregular—single pattern.
- 1d. Irregular—gated pattern.
- 1e. Complicated—single pattern.
- 1f. Complicated—gated pattern.

Job Class 2 Cored Work.
- 2a. Plain—single pattern.
- 2b. Plain—gated pattern.
- 2c. Irregular—single pattern.
- 2d. Irregular—gated pattern.
- 2e. Complicated—single pattern.
- 2f. Complicated—gated pattern.

In addition to the standard times which apply to both cored and non-cored work must be added core setting times for job class 2 work. Times have been established for core setting covering from one to eight cores for a single pattern and from two to 42 cores per mold for gated or plated patterns.

Based on the factors referred to in the three preceding paragraphs, we have the following combinations for any of which it is possible to instantly determine the standard production data directly from the tables, as shown in the following:

Standard production all tabulated and indexed (as per Table III)	36,325
Elemental operation times (bench)	900
Elemental operation times (bench plated)	900
Elemental operation times (machine)	900
Elemental operation times (machine plated)	900
Elemental operation times (core setting)	69
Standard times applying on the above and admitting of an almost unlimited combination	1,440
Operations variable by both job class and mold sizes	900
Total tabulated combinations	42,334

Though the above represents over 42,000 tabulated combinations, it is possible to make up other combinations to meet almost any desired case. It often happens that some variable on a new job throws it out of the standardized tabular group. In such cases, all that it is necessary to do is to add or subtract certain sub-operation times from the standard time sheets.

An immense amount of detail work was necessary before the standardization of all the above variables and their possible combinations were complete. It was necessary to take thousands of time studies. These studies had to apply to a great variety of patterns of all classes and for each of the above mentioned forms of equipment, method and flask sizes. The result of all this work has been gratifying, however.

Results of the Work

All of the standard data has now been tabulated with the result that 95 per cent of all bench and squeezer work done by any of the six foundries of the Aluminum Castings Co. can be put on bonus direct from these tables. This means definite and absolute standardization. Short run work can be put on bonus at once without the necessity for taking time studies on each pattern.

By this method it is possible to apply scientific management methods to a short job which would ordinarily run out long before a satisfactory time study could be made. The importance of this one feature alone must not be under-estimated. As several of the Aluminum Castings Co. foundries do practically a jobbing business, the value of these tables can be readily appreciated.

This standard data has even more value in several other ways than the feature above mentioned. In the first place there is no guess work as to the most economical combination of pattern equipment, number per mold, size of flask, method to be employed, etc. A glance at the tables tells instantly what is the best combinations to employ for each job to assure a maximum production and minimum cost.

Yet another great value is that of having definite data on which to base estimates. This applies both to the routine work of estimating, as well as the solving of problems of this nature by the sales representatives. This is true of both the floor, bench and squeezer data. Combining these advantages and the ability (through accurate analytical costs) to check up past performances puts a firm employing these methods in position to practically predetermine costs.

New equipment can be made to ab-

FIG. 10—MAKING 1,305 HUB CORES PER NINE HOUR DAY

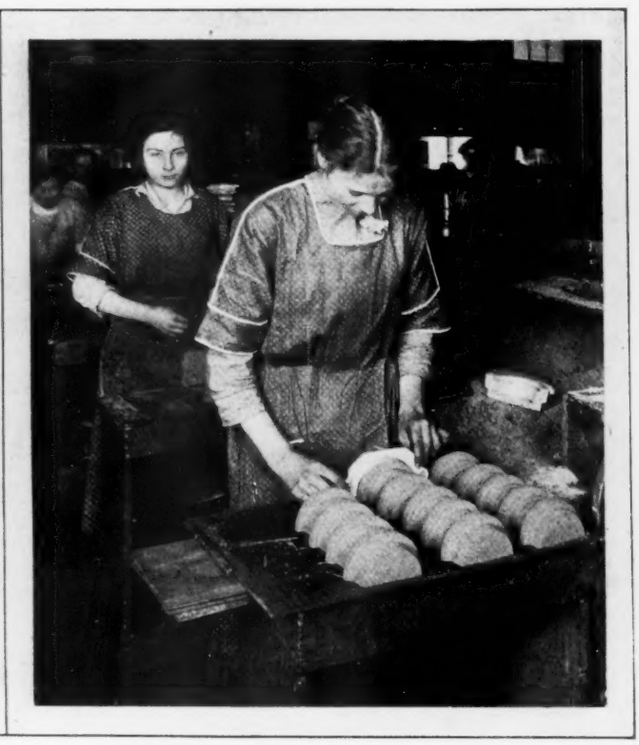


FIG. 11—MAKING 1,620 TRANSMISSION BEARING CORES PER DAY

solutely agree with the best standards and practice. There is no longer need to guess and try "rule of thumb" methods or "cut and dry" until we hit the right way, or the best combinations. It is impossible here to list all of the many advantages to be derived from this data. The results speak for themselves. We are finding new uses and new value in this standardized data every day it is in use.

All bench and squeezer jobs at both the Detroit and Cleveland plants have been put on bonus direct from these standard production data sheets for the last six months. We have to find a case where the men have been unable to reach the production asked for. Neither have the maximum production figures been exceeded. The author claims that the standardization of foundry operations and practice here described marks an epoch in the history of foundry work and is in itself the vindication of scientific management in this virgin field.

Parkhurst Differential Bonus

It is not the intention here to enter into a discussion, academic or otherwise, of the advantages of the various forms of remunerating labor. Based on the writer's experience with day work, piece work, premium and bonus, he has during the last 10 years developed a differential bonus system. The differential system, as described below, has been flexible enough to be readily adaptable to any requirements put upon it. Using the same fundamental principle throughout, the application of the standard differential bonus charts is universal.

The author's experience has been that with properly standardized hourly rates for various grades of labor in each trade involved, the addition of a generous bonus for high production will give greater results than any other method. As he has had occasion to remark before, we pay for the employe's time, we arrange his equipment and supply a more or less complex organization to control that equipment and the materials in process. By positive means we determine the maximum production that the average good man can turn out per day and we certainly have the privilege of utilizing the time we pay for to the best advantage and toward this end. Obviously, however, it is not fair to the worker to prevent his participating in the saving that is realized. We do this by means of increased wages (in the form of bonus) in proportion to the additional work he turns out.

If the employe is assured of a day's pay his mental attitude from the very start is going to be more favorable than if his pay depends entirely on what he turns out for a day's work, as under the piecework system. In a piecework shop the men are often put on strange jobs and though they work hard all day they are not able to earn more than one-third or one-half of a regular day's pay. This may go on for several days before they can make their average piecework day's pay. This obviously is unfair.

By the adoption of standard hourly rates and differential bonus for different classes of work, combined with a proper organization, including an especially strict inspection service, you can much better control your labor and product than you can under the average piecework system.

Use of Differential Bonus

Combine with the above methods accurate information as to exactly what is involved in each job, how long each job should take based on stop watch observations; add to these an openly advertised policy that under no circumstances will you reduce a rate once set. Table IV indicates what the result will be.

To develop and standardize the differential bonus, as used by the author, he decided to provide in standard charts for 15 different bonus classes. This classification applies to the job and not to the man. In other words, jobs are classified as belonging in bonus class 1, 3 or 8, as the case may be. Each bonus class number is equivalent to 25c per day maximum bonus for 100 per cent efficiency. Therefore, a job rated as belonging under bonus class 5 would pay $1.25 maximum bonus for 100 per cent efficiency.

The differential is figured on a basis of 10 per cent of the maximum bonus for 50 per cent production and 100 per cent bonus for 100 per cent production. It might be further explained here that the bonus jobs are seldom started as low as 50 per cent of the calculated maximum of pro-

FIG. 12—TRANSMISSION CASE FLOOR JOB

duction. More generally in a new shop the bonus is started at 60 or 70 per cent, depending on the local shop conditions.

Table IV shows a standard differential bonus chart covering two charts, namely 100 and 101 units per day. The letters A, B, C and D, represent 50, 60, 70 and 80 per cent production respectively. The letter S represents standard production or 100 per cent efficiency.

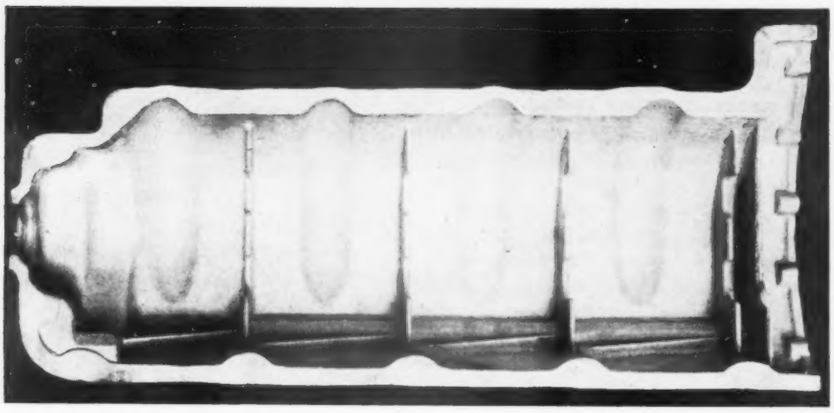


FIG. 13—FOUR-CYLINDER OIL PAN—PRODUCTION, 110 MOLDS PER DAY

Starting the Bonus

To further explain, it should be noted that local plant conditions, the class of help and other variables govern to a great extent the progress than can be made particularly. This is particularly true of the early stages of reorganization work. During these early stages, it is necessary to commence the bonus sometimes as low as 60 and sometimes as low as 50 per cent of the maximum bonus production. This statement can be more readily appreciated when one stops to consider that it is not unusual to ask for five or six times the production per day under bonus that has been the ordinary practice of the shop under day work. If we start bonus (even though it is a small amount) at 50 per cent or 60 per cent of this maximum, we put the bonus nearer the reach of the employe. This tends to encourage him to make a little effort to demonstrate for himself whether bonus can be made or not. Of course, at this stage of his work he has the help of the time study foreman to see that he does not waste time in false moves. As time goes on the average efficiency of the shop becomes higher and the starting point for new jobs can be raised to 70 per cent and later to 80 per cent of the calculated maximum. In all cases the bonus at given percentages is the same on any chart, whether the bonus starts at 60 per cent or at a higher figure. At the Detroit plant of the Aluminum Castings Co. all bonus jobs have been figured to commence at 80 per cent of the maximum bonus production. This 80 per cent factor was established Sept. 1, 1913. We have yet to find a case where the man did not earn bonus, nor have we found any case where the maximum bonus was appreciably exceeded.

It should be understood that the figure of 80 per cent above mentioned, means the point at which the bonus commences. On all jobs it is expected that the average workman will reach 90 per cent to 100 per cent of the maximum production. The exceptional man will go to 100 per cent and beyond.

This exceptional man with the ability to exceed what the average good worker can do is perfectly welcome to the extra remunerations that he gets by exceeding the 100 per cent mark. It should be noted that though the bonus charts are figured to 100 per cent production, if a man should exceed this amount by 5 or 10 per cent the differential is extended down to the figure which he actually realizes. In other words, there is no limit.

Confidence of Workmen

The success of any form of management lies in the confidence which the management is enabled to instill into the personnel. Subterfuge and excuses for changing rates must be absolutely avoided. The writer has always made it a point never to lower a bonus rate once established. This policy is openly published in the shop rules with concerns he has been identified with. He owes the success of his methods in a great measure to the fact that the personal factor has been of paramount consideration with him and all of those who come in contact with him and his methods know that prices will not be lowered, providing, of course, the equipment and method remains unchanged. Furthermore, he uses no "excursion rates". A job once set is fixed forever.

In order not to leave a wrong impression regarding the closing sentence of the preceding paragraph, a word of explanation is desirable. We are continually being confronted with slight changes in pattern equipment or methods that theoretically and fairly would even call for the revision

FIG. 14—BENCH JOB—150 MANIFOLDS PER DAY

of the bonus prices. Where this change of equipment does not make any material difference, say only 5 or 10 per cent, we in the majority of cases let the original bonus chart stand. We are very careful not to take advantage of any slight alteration of equipment to reduce a price. We are also careful to let the man realize that the entire scheme of management from start to finish is one that contemplates fair treatment to him.

Fig. 10 shows a typical core job, on which the average daily production piecework production, which averages 37.5 castings per day. This same man asked to be told a day before the pattern was to go out of the sand so that he and his gang could put up a record that no other gang could touch. It is spirit of this kind which spells co-operation and harmony and gives the greatest results under any form of management.

Fig. 10 shows a typical core job, on which the average daily production is 1,305 cores per nine-hour day. The core illustrated is a Packard hub cap core. Fig. 13 represents another large floor job. This is a four-cylinder oil pan for which three sets of equipment were made to assure the customer of a production of 75 good castings per day. A great many thousand of these pans have been made of this design. The average production runs from 108 to 115 molds per nine-hour day. Another typical core job is illustrated in Fig. 11. This is a transmission bearing core and the average production is 1,620 cores per nine-hour day.

Fig. 12 illustrates a transmission job run by a molding gang of four men and two laborers employed in dumping out and cutting sand. The production on this job averages 160 to 180 good castings per nine-hour day. Fig. 14 illustrates a typical bench job. This is an intake manifold, on which the average production is 150 molds per nine-hour day. Work of this kind, as well as all other bench and squeezer work is covered by the standard data described in preceding sections. Fig. 8 illustrates a small variety of the work covered by these standard tables.

Before closing with the subject of the application of differential bonus, attention is called to Table V. The object of listing so many different items rather than expressing the results ob-

Table III.

STANDARD ELEMENTAL SUB-OPERATIONS FOR FLOOR MOLDING

Reference No.	Sub-operation.
1	Brush off pattern
2	Blow off pattern
3	Dust on parting
4	Set 10 lb. flask
5	Set 20 lb. flask
6	Set 30 lb. flask
7	Set 40 lb. flask
8	Set 80 lb. flask
9	Set 60 lb. flask
10	Set 70 lb. flask
11	Set 80 lb. flask
12	Set 90 lb. flask
13	Set 100 lb. flask
14	Set 120 lb. flask
15	Set 140 lb. flask
16	Set 160 lb. flask
17	Set 180 lb. flask
18	Set 200 lb. flask
19	Set 220 lb. flask
20	Set 1 sprue
21	Set 2 sprue
22	Set 3 sprue
23	Set 4 sprue
24	Set 1 riser
25	Set 2 riser
26	Set 3 riser
27	Set 4 riser
28	Set 5 riser
29	Set 6 riser
30	Set 7 riser
31	Set 8 riser
32	Set 9 riser
33	Set 10 riser
34	Set 11 riser
35	Set 12 riser
36	Sift sand ¼-inch deep
37	Sift sand ½-inch deep
38	Sift sand on pattern 1 inch high
39	Sift sand on pattern 2 inches high
40	Sift sand on pattern 3 inches high
41	Sift sand on pattern 4 inches high
42	Sift sand on pattern 5 inches high
43	Sift sand on pattern 6 inches high
44	Sift sand on pattern 7 inches high
45	Sift sand on pattern 8 inches high
46	Sift sand on pattern 9 inches high
47	Sift sand on pattern 10 inches high
48	Sift sand on pattern 11 inches high
49	Sift sand on pattern 12 inches high
50	Press sand around pattern
51	Tuck straight bans
52	Tuck slant out bans
53	Tuck Vertical bans
54	Tuck irregular bans
55	Shovel in 4 inches sand
56	Shovel in 5 inches sand
57	Shovel in 6 inches sand
58	Shovel in 7 inches sand
59	Shovel in 8 inches sand
60	Shovel in 9 inches sand
61	Shovel in 10 inches sand
62	Shovel in 11 inches sand
63	Shovel in 12 inches sand
64	Shovel in 13 inches sand
65	Shovel in 14 inches sand
66	Shovel in 15 inches sand
67	Ram 4 inches sand "light"
68	Ram 4 inches sand "medium"
69	Ram 4 inches sand "hard"
70	Ram 6 inches sand "light"
71	Ram 6 inches sand "medium"
72	Ram 6 inches sand "hard"
73	Ram 8 inches sand "light"
74	Ram 8 inches sand "medium"
75	Ram 8 inches sand "hard"
76	Fill flask 3 inches above top
77	Fill flask 4 inches above top
78	Fill flask 5 inches above top
79	Fill flask 6 inches above top
80	Step off
81	Butt ram
82	Level off "shovel"
83	Level off "hard"
84	Strike off
85	Pull 1 sprue
86	Pull 2 sprue
87	Pull 3 sprue
88	Pull 4 sprue
89	Pull 1 riser
90	Pull 2 riser
91	Pull 3 riser
92	Pull 4 riser
93	Pull 5 riser
94	Pull 6 riser
95	Pull 7 riser
96	Pull 8 riser
97	Pull 9 riser
98	Pull 10 riser
99	Pull 11 riser
100	Pull 12 riser
101	Level off before board goes on
102	Put on board
103	Rub board to good bearing
104	Clamp board with 2 clamps
105	Clamp board with 4 clamps
106	Clamp board with 6 clamps
107	Clamp board with 2 clamps and wedge
108	Clamp board with 4 clamps and wedge
109	Clamp board with 6 clamps and wedge
110	Clamp board with automatic clamp
111	Roll over by hand, 1 man
112	Roll over by hand, 2 men
113	Roll over by hand, 3 men
114	Roll over by hand, 4 men
115	Roll over by hand, 5 men
116	Roll over by hand, 6 men
117	Roll over by hand, 7 men
118	Roll over by hand, 8 men
119	Roll over by hand, 9 men
120	Roll over by hand, 10 men
121	Roll Tabor hand rollover mch., 1 man
122	Roll Tabor hand rollover mch., 2 men
123	Roll Tabor hand rollover mch., 3 men
124	Roll Tabor hand rollover mch., 4 men
125	Roll Pridmore rollover mch., 1 man
126	Roll Pridmore rollover mch., 2 men
127	Roll Pridmore rollover mch., 3 men
128	Roll Pridmore rollover mch., 4 men
129	Rollover Tabor power rollover mch.
130	Rollover Pridmore power rollover mch.
131	Wedge up under board
132	Unclamp (See above item No. 107)
133	Unclamp (See above item No. 108)
134	Unclamp (See above item No. 109)
135	Rap by hand
136	Rap by vibrator
137	Rap by hand and draw pattern on machine, 1 inch
138	Rap by hand and draw pattern on machine, 2 inches
139	Rap by hand and draw pattern on machine, 3 inches
140	Rap by hand and draw pattern on machine, 4 inches
141	Rap by hand and draw pattern on machine, 5 inches
142	Rap by hand and draw pattern on machine, 6 inches
143	Rap by hand and draw pattern on machine, 7 inches
144	Rap by hand and draw pattern on machine, 8 inches
145	Rap by hand and draw pattern on machine, 9 inches
146	Rap by hand and draw pattern on machine, 10 inches
147	Rap by hand and draw pattern on machine, 11 inches
148	Rap by hand and draw pattern on machine, 12 inches
149	Draw pattern by hand, 1 inch
150	Draw pattern by hand, 2 inches
151	Draw pattern by hand, 3 inches
152	Draw pattern by hand, 4 inches
153	Draw pattern by hand, 5 inches
154	Draw pattern by hand, 6 inches
155	Draw pattern by hand, 7 inches
156	Draw pattern by hand, 8 inches
157	Draw pattern by hand, 9 inches
158	Draw pattern by hand, 10 inches
159	Draw pattern by hand, 11 inches
160	Draw pattern by hand, 12 inches
161	Draw pattern on machine, 1 inch
162	Draw pattern on machine, 2 inches
163	Draw pattern on machine, 3 inches
164	Draw pattern on machine, 4 inches
165	Draw pattern on machine, 5 inches
166	Draw pattern on machine, 6 inches
167	Draw pattern on machine, 7 inches
168	Draw pattern on machine, 8 inches
169	Draw pattern on machine, 9 inches
170	Draw pattern on machine, 10 inches
171	Draw pattern on machine, 11 inches
172	Draw pattern on machine, 12 inches
173	Return machine to ramming position

tained in total lump figures, is to show up the great difference in production increases and cost decreases between different jobs. In other words, it will be noted that production increase runs from only a few per cent to over 700 per cent. The figures in the cost decrease column in a few instances show practically no decrease in cost and in others the decrease is 80 or more per cent. These figures illustrate better than can be done in any other way, the great variations that exist in the average job, both as to the production standard and direct costs. In other words, under ordinary methods, it is comparatively easy for jobs to be limited in production due to the apparent similarity between one job and another. These figures also show up the great difference between what in the judgment of the average good mechanic should be a day's work and what actually should be realized when the facts are accurately determined.

Comparison of Analysis and Shrinkage

By W. J. Keep

Question:—Formerly we depended upon the chemical analysis of our mixtures to ascertain the required amount of silicon to produce a given shrinkage. In some mixtures it seemed necessary to use more silicon than in others to obtain the desired shrinkage. It was suggested to us that this was due to the fact that the manganese was low. Kindly advise us whether we should pay more attention to the proportions of sulphur, silicon, phosphorus and manganese when purchasing pig iron.

Answer:—The measure of shrinkage reflects the influence of all of these chemical elements as well as the heat treatment of the casting—whether the iron is melted dull or hot, whether it is poured dull or hot whether it is permitted to cool in the mold or shaken-out hot—in other words, it tells what kind of a casting you have produced. From an analysis of the casting you can calculate a mixture that will duplicate the work, provided it is what you desire. It will be found that low sulphur, reasonably low phosphorus and manganese and silicon, high for soft castings and low for hard castings, will give the best results. Always purchase iron and coke with this in mind. With the other elements as previously specified, increased silicon will decrease shrinkage and combined carbon and will soften the castings. Reducing the silicon will give high combined carbon, increased shrinkage and harder castings. If you find that your shrinkage increases, increase the percentage of silicon, and if the shrinkage is lower than it should be, increase the percentage of scrap. This works well in practice and if you use the same irons at all times, it is fairly accurate. If you desire to purchase another brand of pig iron, buy one car and try it out in place of some iron in your mixture. If the silicon is higher than in the iron that you have used, the

Table IV.

STANDARD DIFFERENTIAL BONUS CHART

Bonus Product'n in Units per day for		BONUS CLASSES (The decimal over the bonus class figures are the differential or increment of change.)														
Chart. 100	Chart. 101	0.0045 1	0.009 2	0.0135 3	0.018 4	0.0225 5	0.027 6	0.0315 7	0.036 8	0.0405 9	0.045 10	0.0495 11	0.054 12	0.0585 13	0.063 14	0.0675 15
A 50	51	0.025	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.225	0.250	0.275	0.300	0.325	0.350	0.375
51	52	0.030	0.059	0.089	0.118	0.148	0.177	0.207	0.236	0.266	0.295	0.325	0.354	0.384	0.413	0.443
52	53	0.034	0.068	0.102	0.136	0.170	0.204	0.238	0.272	0.306	0.340	0.374	0.408	0.442	0.476	0.510
53	54	0.039	0.077	0.116	0.154	0.193	0.231	0.270	0.308	0.347	0.385	0.424	0.462	0.501	0.539	0.578
54	55	0.043	0.086	0.129	0.172	0.215	0.258	0.301	0.344	0.387	0.430	0.473	0.516	0.559	0.602	0.645
55	56	0.048	0.095	0.143	0.190	0.238	0.285	0.333	0.380	0.428	0.475	0.523	0.570	0.618	0.665	0.713
56	57	0.052	0.104	0.156	0.208	0.260	0.312	0.364	0.416	0.468	0.520	0.572	0.624	0.676	0.728	0.780
57	58	0.057	0.113	0.170	0.226	0.283	0.339	0.396	0.452	0.509	0.565	0.622	0.678	0.735	0.791	0.848
58	59	0.061	0.122	0.183	0.244	0.305	0.366	0.427	0.488	0.549	0.610	0.671	0.732	0.793	0.854	0.915
59	60	0.066	0.131	0.197	0.262	0.328	0.393	0.459	0.524	0.590	0.655	0.721	0.786	0.852	0.917	0.983
B 60	61	0.070	0.140	0.210	0.280	0.350	0.420	0.490	0.560	0.630	0.700	0.770	0.840	0.910	0.980	1.050
61	62	0.075	0.149	0.224	0.298	0.373	0.447	0.522	0.596	0.671	0.745	0.820	0.894	0.969	1.043	1.118
62	63	0.079	0.158	0.237	0.316	0.395	0.474	0.553	0.632	0.711	0.790	0.869	0.948	1.027	1.106	1.185
63	64	0.084	0.167	0.251	0.334	0.418	0.501	0.585	0.668	0.752	0.835	0.919	1.002	1.086	1.169	1.253
64	65	0.088	0.176	0.264	0.352	0.440	0.528	0.616	0.704	0.792	0.880	0.968	1.056	1.144	1.232	1.320
65	66	0.093	0.185	0.278	0.370	0.463	0.555	0.648	0.740	0.833	0.925	1.018	1.110	1.203	1.295	1.388
66	67	0.097	0.194	0.291	0.388	0.485	0.582	0.679	0.776	0.873	0.970	1.067	1.164	1.261	1.358	1.455
67	68	0.102	0.203	0.305	0.406	0.508	0.609	0.711	0.812	0.914	1.015	1.117	1.218	1.320	1.421	1.523
68	69	0.106	0.212	0.318	0.424	0.530	0.636	0.742	0.848	0.954	1.060	1.166	1.272	1.378	1.484	1.500
69	70	0.111	0.221	0.332	0.442	0.553	0.663	0.774	0.884	0.995	1.105	1.216	1.326	1.437	1.547	1.658
C 70	71	0.115	0.230	0.345	0.460	0.575	0.690	0.805	0.920	1.035	1.150	1.265	1.380	1.495	1.610	1.725
71	72	0.120	0.239	0.359	0.478	0.598	0.717	0.837	0.956	1.076	1.195	1.315	1.434	1.554	1.673	1.793
72	73	0.124	0.248	0.372	0.496	0.620	0.744	0.868	0.992	1.116	1.240	1.364	1.488	1.612	1.736	1.860
73	74	0.129	0.257	0.386	0.514	0.643	0.771	0.900	1.028	1.157	1.285	1.414	1.542	1.671	1.799	1.928
74	75	0.133	0.266	0.399	0.532	0.665	0.798	0.931	1.064	1.197	1.330	1.463	1.596	1.729	1.862	1.995
75	76	0.138	0.275	0.413	0.550	0.688	0.825	0.963	1.100	1.238	1.375	1.513	1.650	1.788	1.925	2.063
76	77	0.142	0.284	0.426	0.568	0.710	0.852	0.994	1.136	1.278	1.420	1.562	1.704	1.846	1.988	2.130
77	78	0.147	0.293	0.440	0.586	0.733	0.879	1.026	1.172	1.319	1.465	1.612	1.758	1.905	2.051	2.198
78	79	0.151	0.302	0.453	0.604	0.755	0.906	1.057	1.208	1.359	1.510	1.661	1.812	1.963	2.114	2.265
79	80	0.156	0.311	0.467	0.622	0.778	0.933	1.089	1.244	1.400	1.555	1.711	1.866	2.022	2.177	2.333
D 80	81	0.160	0.320	0.480	0.640	0.800	0.960	1.120	1.280	1.440	1.600	1.760	1.920	2.080	2.240	2.400
81	82	0.165	0.329	0.494	0.658	0.823	0.987	1.152	1.316	1.481	1.645	1.810	1.974	2.139	2.303	2.468
82	83	0.169	0.338	0.507	0.676	0.845	1.014	1.183	1.352	1.521	1.690	1.859	2.028	2.197	2.366	2.535
83	84	0.174	0.347	0.521	0.694	0.868	1.041	1.215	1.388	1.562	1.735	1.909	2.082	2.256	2.429	2.603
84	85	0.178	0.356	0.534	0.712	0.890	1.068	1.246	1.424	1.602	1.780	1.958	2.136	2.314	2.492	2.670
85	86	0.183	0.365	0.548	0.730	0.913	1.095	1.278	1.460	1.643	1.825	2.008	2.190	2.373	2.555	2.738
86	87	0.187	0.374	0.561	0.748	0.935	1.122	1.309	1.496	1.683	1.870	2.057	2.244	2.431	2.168	2.805
87	88	0.192	0.383	0.575	0.766	0.958	1.149	1.341	1.532	1.724	1.915	2.107	2.298	2.490	2.681	2.873
88	89	0.196	0.392	0.588	0.784	0.980	1.176	1.372	1.568	1.764	1.960	2.156	2.352	2.548	2.744	2.940
89	90	0.201	0.401	0.602	0.802	1.003	1.203	1.404	1.604	1.805	2.005	2.206	2.406	2.607	2.807	3.008
90	91	0.205	0.410	0.615	0.820	1.025	1.230	1.435	1.640	1.845	2.050	2.255	2.460	2.665	2.870	3.075
91	92	0.210	0.419	0.629	0.838	1.048	1.257	1.467	1.676	1.886	2.095	2.305	2.514	2.724	2.933	3.143
92	93	0.214	0.428	0.642	0.856	1.070	1.284	1.498	1.712	1.926	2.140	2.354	2.568	2.782	2.996	3.210
93	94	0.219	0.437	0.656	0.874	1.093	1.311	1.530	1.748	1.967	2.185	2.404	2.622	2.481	3.059	3.278
94	95	0.223	0.446	0.669	0.892	1.115	1.338	1.561	1.784	2.007	2.230	2.453	2.676	2.899	3.122	3.345
95	96	0.228	0.455	0.683	0.910	1.138	1.365	1.593	1.820	2.048	2.275	2.503	2.730	2.958	3.185	3.413
96	97	0.232	0.464	0.696	0.928	1.160	1.392	1.624	1.856	2.088	2.320	2.552	2.784	3.016	3.248	3.480
97	98	0.237	0.473	0.710	0.946	1.183	1.419	1.656	1.892	2.129	2.365	2.602	2.838	3.075	3.311	3.548
98	99	0.241	0.482	0.723	0.964	1.205	1.446	1.687	1.928	2.169	2.410	2.651	2.892	3.133	3.374	3.615
99	100	0.246	0.491	0.737	0.982	1.228	1.473	1.719	1.964	2.210	2.455	2.701	2.946	3.192	3.437	3.683
S 100	101	0.250	0.500	0.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000	3.250	3.500	3.750

NOTE.—S = Standard production for specific conditions, as defined by the instruction card for each job and based on accurate stop watch observations. A, B, C or D represent quantity at which bonus is to commence; once determined for a job this starting point is never changed for that job. Opposite the quantity per day will be found in each column (Bonus Class) the bonus per day in dollars and cents for that class.

WEIGHT OF RODS OR CYLINDERS PER RUNNING INCH

By W. L. Tryon

Dia. in in.	Cast iron.	Steel.	Alum-inum.	Cop-per.	Zinc.	Gun metal.	Yellow brass.
20¼	83.87	91.24	31.02	102.9	81.32	101.7	97.42
20½	85.95	93.51	31.79	105.5	83.34	104.1	99.85
20¾	88.06	95.80	32.57	108.1	85.39	106.6	102.3
21	90.19	98.13	33.36	110.7	87.46	109.2	104.8
21¼	92.35	100.5	34.15	113.3	89.55	111.8	107.3
21½	94.54	102.9	34.96	116.0	91.67	114.4	109.8
21¾	96.75	105.3	35.78	118.7	93.82	117.1	112.4
22	98.99	107.7	36.61	121.5	95.98	119.8	115.0
22¼	101.2	110.2	37.45	124.2	98.18	122.5	117.6
22½	103.5	112.6	38.29	127.0	100.4	125.3	120.3
22¾	105.9	115.2	39.15	129.9	102.6	128.2	123.0
23	108.2	117.7	40.01	132.7	104.9	130.9	125.7
23¼	110.6	120.3	40.89	135.6	107.2	133.8	128.4
23½	112.9	122.9	41.77	138.5	109.5	136.6	131.2
23¾	115.4	125.5	42.67	141.5	111.9	139.6	134.0
24	117.8	128.2	43.57	144.5	114.2	142.6	136.9
24¼	120.3	130.9	44.48	147.5	116.6	145.5	139.7
24½	122.8	133.6	45.40	150.6	119.0	148.6	142.6
24¾	125.3	136.3	46.33	153.7	121.5	151.6	145.5
25	127.8	139.1	47.27	156.8	124.0	154.7	148.5
25¼	130.4	141.9	48.22	160.0	126.4	157.8	151.5
25½	133.0	144.7	49.18	163.0	129.0	160.9	154.5
25¾	135.6	147.5	50.15	166.4	131.5	164.2	157.5
26	138.3	150.4	51.13	169.6	134.1	167.3	160.6
26¼	140.9	153.3	52.12	172.9	136.7	170.6	163.7
26½	143.6	156.3	53.12	176.2	139.3	173.8	166.8
26¾	146.3	159.2	54.12	179.6	141.9	177.2	170.0
27	149.1	162.2	55.14	183.0	144.6	180.5	173.2
27¼	151.9	165.2	56.17	186.4	147.3	183.9	176.4
27½	154.7	168.3	57.20	189.8	150.0	187.3	180.0
27¾	157.5	171.3	58.25	193.2	152.7	190.6	182.9
28	160.3	174.4	59.30	196.7	155.5	194.1	186.3
28¼	163.2	177.6	60.36	200.3	158.3	197.3	189.6
28½	166.1	180.7	61.44	203.8	161.1	201.1	193.0
28¾	169.0	183.9	62.52	207.4	163.9	204.7	196.4
29	172.0	187.1	63.61	211.0	166.8	208.2	199.8
29¼	175.0	190.4	64.71	214.7	169.7	211.8	203.3
29½	178.0	193.6	65.82	218.3	172.6	215.4	206.7
29¾	181.0	196.9	66.94	222.1	175.5	219.1	210.3
30	184.1	200.3	68.08	225.8	178.5	222.8	213.8
30¼	187.2	203.6	69.21	229.6	181.5	226.5	217.4
30½	190.3	207.0	70.36	233.4	184.5	230.3	221.0
30¾	193.4	210.4	71.52	237.3	187.5	234.1	224.6
31	196.6	213.8	72.69	241.1	190.6	237.9	228.3
31¼	199.7	217.3	73.87	245.1	193.7	241.8	232.0
31½	202.9	220.8	75.05	249.0	196.8	245.6	235.7
31¾	206.2	224.3	76.25	253.0	199.9	249.6	239.5
32	209.4	227.9	77.45	257.0	203.1	253.5	243.3
32¼	212.7	231.4	78.67	261.0	206.3	257.5	247.1
32½	216.0	235.0	79.89	265.1	209.4	261.5	250.9
32¾	219.4	238.7	81.13	269.1	212.7	265.5	254.8
33	222.7	242.3	82.37	273.3	216.0	269.6	258.7
33¼	226.1	246.0	83.62	277.4	219.3	273.7	262.6
33½	229.5	249.7	84.88	281.6	222.6	277.8	266.6
33¾	233.0	253.5	86.15	285.8	225.9	281.0	270.6
34	236.4	257.2	87.44	290.1	229.3	286.2	274.6
34¼	239.9	261.0	88.73	294.4	232.6	290.5	278.7
34½	243.4	264.8	90.03	298.7	236.1	294.7	282.7
34¾	247.0	268.7	91.34	303.0	239.5	299.0	286.9
35	250.5	272.6	92.65	307.4	243.0	303.3	291.0
35¼	254.1	276.5	93.98	311.8	246.4	307.6	295.2
35½	257.7	280.4	95.32	316.2	249.9	312.0	299.4
35¾	261.4	284.4	96.67	320.7	253.5	316.4	303.6
36	265.1	288.4	98.02	325.2	257.0	320.9	307.9
36¼	268.7	292.4	99.39	329.7	260.6	325.3	312.2
36½	272.5	296.4	100.8	334.3	264.2	329.8	316.5
36¾	276.2	300.5	102.1	338.9	267.8	334.4	320.8
37	280.0	304.6	103.5	343.5	271.5	338.9	325.2
37¼	283.8	308.7	104.9	348.2	275.2	343.5	329.6
37½	287.6	312.9	106.4	352.9	278.9	348.4	334.1
37¾	291.4	317.1	107.8	357.6	282.6	352.8	338.5
38	295.3	321.3	109.2	362.3	286.4	357.5	343.0
38¼	299.2	325.5	110.7	367.1	290.1	362.2	347.6
38½	303.1	329.8	112.1	371.9	294.0	366.5	352.1
38¾	307.1	334.1	113.6	376.8	297.8	371.7	356.7
39	311.1	338.4	115.0	381.7	301.6	376.6	361.4
40	327.2	356.0	121.0	401.5	317.3	396.1	380.1
41	343.8	374.0	127.1	421.8	333.4	416.2	399.4

For finding weights of rods or cylinders of any length, see Data Sheet No. 177.

WEIGHT OF RODS OR CYLINDERS PER RUNNING INCH

By W. L. Tryon

Dia. in in.	Cast iron.	Steel.	Alum-inum.	Cop-per.	Zinc.	Gun met'l.	Yel. brass.
42	360.8	395.5	133.4	442.6	349.8	436.7	419.1
43	378.1	411.4	139.8	464.0	366.7	457.8	439.3
44	395.9	430.8	146.4	485.8	383.9	479.3	460.0
45	414.2	450.6	153.2	508.1	401.6	501.3	481.1
46	432.7	470.8	160.0	531.0	419.6	523.9	502.7
47	451.8	491.5	167.1	554.3	438.1	546.9	524.8
48	471.2	512.7	174.3	578.1	456.9	570.4	547.4
49	491.1	534.2	181.6	602.5	476.2	593.4	570.4
50	511.3	556.3	189.1	627.3	495.8	618.9	594.0
51	531.9	578.7	196.7	652.7	515.8	644.0	618.0
52	553.0	601.7	204.5	678.5	536.2	669.4	642.4
53	574.5	625.0	212.4	704.9	557.1	695.5	667.4
54	596.4	648.8	220.5	731.7	578.3	721.9	692.8
55	618.7	673.1	228.8	759.0	599.9	748.9	718.7
56	641.4	697.8	237.2	786.9	621.9	776.4	745.0
57	664.5	722.9	245.7	815.3	644.3	804.4	771.9
58	688.0	748.5	254.4	844.1	667.1	832.9	799.2
59	711.9	774.5	263.3	873.5	690.3	861.8	827.0
60	736.3	801.0	272.3	903.4	713.9	891.3	855.2
61	761.0	827.9	281.4	933.7	737.9	921.3	884.0
62	786.2	855.3	290.7	964.6	762.3	951.7	913.2
63	811.7	883.1	300.2	995.9	787.1	982.6	942.9
64	837.7	911.4	309.8	1028	812.3	1014	973.1
65	864.1	940.1	319.6	1060	837.9	1046	1004
66	890.9	969.2	329.5	1093	863.9	1078	1035
67	918.1	998.8	339.5	1126	890.2	1111	1066
68	945.7	1029	349.7	1160	917.0	1144	1099
69	973.7	1059	360.1	1195	944.2	1179	1131
70	1002	1090	370.6	1230	971.7	1213	1164
71	1031	1122	381.3	1265	999.7	1248	1198
72	1060	1153	392.1	1301	1028	1284	1232
73	1090	1186	403.1	1337	1057	1319	1266
74	1120	1218	414.2	1374	1086	1355	1301
75	1150	1252	425.4	1411	1116	1392	1336
76	1181	1285	436.9	1449	1145	1429	1372
77	1213	1319	448.4	1488	1176	1468	1409
78	1244	1354	460.2	1527	1207	1506	1446
79	1276	1389	472.0	1566	1238	1545	1483
80	1309	1424	484.1	1606	1269	1584	1521
81	1342	1460	496.2	1646	1301	1624	1559
82	1375	1496	508.6	1687	1334	1664	1598
83	1409	1533	521.1	1729	1366	1706	1637
84	1443	1570	533.7	1771	1399	1747	1676
85	1478	1608	546.4	1813	1433	1789	1717
86	1513	1646	559.4	1856	1467	1830	1757
87	1548	1684	572.5	1899	1501	1873	1798
88	1584	1723	585.7	1943	1536	1917	1840
89	1620	1762	599.1	1988	1571	1961	1882
90	1657	1802	612.6	2033	1606	2006	1924
91	1694	1843	626.3	2078	1642	2050	1967
92	1731	1883	640.1	2124	1679	2095	2011
93	1769	1924	654.1	2170	1715	2141	2055
94	1807	1966	668.3	2217	1752	2188	2099
95	1846	2008	682.6	2265	1790	2235	2144
96	1885	2051	697.0	2313	1828	2282	2190
97	1924	2094	711.6	2361	1866	2329	2236
98	1964	2137	726.4	2410	1905	2378	2282
99	2004	2181	741.3	2459	1944	2426	2329
100	2045	2225	756.3	2509	1983	2477	2376
101	2086	2270	771.5	2560	2023	2526	2424
102	2128	2315	786.9	2611	2063	2576	2472
103	2170	2361	802.4	2662	2104	2627	2521
104	2212	2407	818.1	2714	2145	2677	2570
105	2255	2453	833.9	2767	2186	2728	2619
106	2298	2500	849.8	2819	2228	2780	2669
107	2342	2547	866.0	2873	2270	2834	2720

The weight per running inch for a diameter with a fraction such as 82⅜ can be found by interpolation as follows:

Add the product of the fractional part of the diameter multiplied by the difference between the weights in table corresponding to the next even inches above and below the given diameter to the weight corresponding to the next even inch under, the result being the required weight per running inch: Thus for cast iron ring 82⅜ diameter, from table 83 = 1409 82 = 1375 1409 − 1375 = 34, 34 × ⅜ = 13; 1375 + 13 = 1388, weight per running inch for 82⅜ diameter.

For finding weights of rods or cylinders of any length, see Data Sheet No. 177.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, FEBRUARY, 1915

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

shrinkage will decline. This statement regarding the influence of silicon, however, applies only up to about 3 per cent. Above that point silicon makes iron hard. For machinery castings the percentage of silicon should rarely be in excess of 2.50 per cent and for light machinery castings not below 2 per cent, because slower coaling separates the graphite and makes the casting soft.

The W. S. Rockwell Co., furnace engineer, 50 Church street, New York City, has issued an interesting comparative scale of Fahrenheit and Centigrade thermometers. The scale is arranged in the form of a circle and covers a range in temperature from 0 to 3200 degrees Fahr. Tables of hardening heats, tempering heats and temperature conversion factors also are given. The whole is printed on a stiff, 9½ x 11-inch card, which may be hung on the wall of the furnace or heat-treating room.

Proper Eye Protectors

In a large shop in New York state all the chippers are provided with eye protectors. Only a short time ago one of these workmen was struck in the eye by a very heavy chip of metal which drove the glass back through the frame of the protection glasses he was wearing. His eye was so seriously injured by this glass that it had to be removed. These glasses gave no protection from broken glass. The case was settled for $4,000. On the other hand, one of the largest steel works in this country provides the men with safety glasses which have a safety flange extending over the back of the glass. This flange prevents glass passing through and injuring the eye. Recently one of the workmen in this plant was struck by a swinging crane hook. The terrific force of the blow smashed the glasses and stunned the man, but not an atom of glass entered his eye. This shows that the danger is not so much from small pieces of glass, as from all the glass being driven through the frame and cutting through the eyelid and eye ball.

New San Francisco Laboratory

The Charles C. Kawin Co., Chicago, has established a laboratory at San Francisco in charge of William J. Mulcahy, secretary of this company. This office has been established to meet the requirements of the rapidly growing western trade of the Charles C. Kawin Co. and to better meet the needs of the foundrymen on the Pacific coast in giving them advice on their melting operations, furnishing them with chemical analyses and making mixtures and physical tests.

The J. W. Paxson Co., Philadelphia, is sending to the trade a handsomely illustrated and exceedingly practical wall calendar.

Table V.

TABLE OF PRODUCTION AND DIRECT LABOR COST COMPARISONS.

		Old Method Including Day, Piece and Premium Work.			New Method Under Scientific Management and Differential Bonus.						Old Method Including Day, Piece and Premium Work.			New Method Under Scientific Management and Differential Bonus.				
Item.	Operation.	Good pieces per day.	Total cost.	Cost per good piece.	Good pieces per day.	Total cost.	Cost per good piece.	Good prod., increase per cent.	Cost reduced, per cent.	Item.	Operation.	Good pieces per day.	Total cost.	Cost per good piece.	Good pieces per day.	Total cost.	Cost per good piece.	Good prod., increase per cent.	Cost reduced, per cent.
1	MD	30.9	$11.79	$ .382	54.	$17.18	$ .318	75.	16.8	60	MC	85.	1.39	.0164	316.	1.91	.006	272.	63.4
2	MD	34.	13.43	.395	66.7	19.50	.293	96.	25.8	61	MC	160.	1.39	.0087	450.	2.51	.0058	181.	33.3
3	MD	22.62	9.75	.430	65.6	18.26	.278	190.	35.4	62	MC	120.	1.75	.0146	270.	2.33	.0086	125.	41.
4	MD	74.	8.36	.113	112.	11.16	.099	51.3	12.4	63	MC	85.	1.00	.0118	190.	1.00	.0053	112.	55.
5	MD	14.25	16.24	1.140	16.33	19.50	1.193	14.25	4.7	65	MC	220.	1.71	.0078	720.	3.01	.0042	227.	46.2
6	MC	40.	4.80	.120	65.	5.21	.080	62.	33.3	67	MC	150.	1.39	.0093	421.	1.78	.0042	180.	54.8
7	MC	42.5	4.46	.105	55.	3.68	.067	29.2	36.2	68	MC	180.	1.26	.007	447.	1.83	.0041	148.	41.5
8	MC	42.5	4.25	.100	55.	4.43	.081	29.2	19.	69	MC	180.	1.26	.007	419.	1.83	.0047	133.	32.9
9	MC	42.5	4.68	.110	55.	3.93	.072	29.2	34.5	70	MC	125.	1.50	.012	151.	1.80	.0119	21.	0.
10	MC	42.5	3.83	.090	55.	4.43	.081	29.2	10.	71	MC	108.	1.26	.0117	214.	1.98	.0093	98.	20.5
11	MC	42.5	3.83	.090	55.	4.43	.081	29.2	10.	72	MC	24.	2.75	.1144	59.	4.02	.0682	145.	40.3
12	MC	42.5	4.25	.100	55.	3.60	.065	29.2	35.	73	MC	23.	2.75	.1195	55.	4.14	.0753	139.	37.
13	MC	93.	5.12	.055	90.	3.31	.037	3.2	32.7	74	MC	73.	2.50	.0343	140.	2.50	.0179	91.8	47.8
14	MC	58.	5.51	.095	80.	4.08	.051	38.9	56.8	75	MC	190.	1.13	.0059	378.	1.49	.0039	99.	33.9
15	MC	50.	2.00	.040	110.	3.10	.028	120.	30.	76	MC	220.	1.13	.0051	600.	2.21	.0037	173.	27.4
16	MD	29.5	8.25	.280	52.	9.97	.192	73.	31.4	77	MC	220.	1.71	.0078	579.	2.43	.0042	163.	46.2
17	MC	125.	6.00	.040	200.	4.57	.023	60.	42.5	78	MC	41.	2.50	.061	99.	3.65	.0369	141.5	39.6
18	MC	80.	4.00	.050	100.	3.59	.036	25.	28.	79	MC	60.	2.25	.0375	222.	4.62	.0208	270.	44.5
19	MC	220.	5.50	.025	240.	4.27	.0178	9.	28.8	80	MC	35.	2.25	.0643	63.	2.97	.0472	80.	26.6
20	MD	37.5	16.06	.428	76.2	18.89	.248	103.2	41.8	81	MC	75.	3.00	.04	172.	5.36	.0312	129.	22.
21	MD	33.	10.75	.326	76.2	14.90	.195	131.	40.2	82	MC	42.	2.75	.0655	80.	4.07	.0509	90.	22.3
22	MD	72.	7.00	.097	138.	7.00	.051	92.	47.5	83	MC	400.	1.26	.0032	694.	1.67	.0024	73.5	25.
23	MC	75.	3.00	.040	180.	5.30	.0294	140.	26.5	84	MC	23.	2.50	.1086	50.	4.35	.0871	117.	19.8
24	MD	44.7	8.00	.179	74.8	8.00	.107	673.	40.2	85	MC	23.	2.50	.1086	56.	4.18	.0748	143.5	31.1
27	MD	11.8	15.50	1.313	27.	23.96	.890	128.	32.2	86	MC	37.	5.50	.1485	81.	9.78	.1206	119.	18.8
28	MD	27.5	7.75	.282	42.6	9.09	.213	55.	24.4	87	MC	650.	1.26	.0019	1200.	1.83	.0015	84.6	21.
29	MC	25.	5.00	.200	34.	3.51	.103	36.	48.4	88	MD	88.	7.75	.0881	172.	10.25	.0596	104.6	32.4
30	MD	51.	11.00	.216	81.2	11.00	.135	59.2	37.5	89	MC	45.	2.75	.0612	68.	3.23	.0475	51.1	22.4
31	MD	15.15	18.23	1.196	34.6	31.59	.913	129.1	30.9	90	MC	25.	2.50	.10	37.	3.50	.0947	48.	5.3
32	MD	18.2	10.75	.592	33.3	15.47	.465	83.	21.4	91	MC	45.	3.00	.0666	127.	5.03	.0396	182.	40.5
33	MD	14.8	15.75	1.063	28.	22.78	.814	89.	23.4	92	MC	110.	1.39	.0126	210.	1.77	.0084	91.	33.3
35	MD	9.8	13.25	1.353	25.2	24.90	.988	157.3	27.	93	MD	15.8	9.25	.585	23.1	9.25	.402	46.2	31.3
36	MD	12.2	12.25	1.004	31.	15.695	.506	154.1	48.6	94	MC	190.	1.26	.0066	585.	2.42	.0041	208.	37.9
37	MD	21.5	8.25	.384	46.6	11.42	.245	116.7	36.2	95	MD	18.2	10.75	.592	33.3	15.47	.465	83.	21.4
38	MD	44.9	8.00	.178	80.2	11.12	.139	78.5	21.9	96	MC	180.	1.39	.0077	431.	1.85	.0043	139.5	44.2
39	MD	65.	7.75	.119	127.6	10.39	.081	96.3	31.9	97	MC	240.	1.50	.0063	492.	1.94	.0039	105.	38.1
40	MC	58.	3.00	.0518	90.	4.12	.0458	55.	16.	101	MC	130.	1.75	.0135	278.	2.18	.0078	114.	42.2
42	MD	13.	16.50	1.27	23.	16.50	.718	77.	43.5	102	MC	270.	1.00	.0037	509.	1.69	.0033	88.5	10.8
43	MD	45.1	11.75	.26	54.	11.75	.217	19.9	19.8	103	MC	35.	2.92	.0835	92.	3.85	.0418	163.	50.
44	MD	10.8	3.25	.301	25.6	4.63	.181	137.	40.	104	MC	35.	3.24	.092	96.	4.984	.052	174.28	43.4
45	MC	50.	3.00	.060	151.	5.63	.0373	202.	37.8	107	MC	82.	3.24	.039	187.	3.25	.017	128.	56.4
46	MC	33.	4.50	.136	65.	5.93	.0913	97.	32.9	109	MC	55.	3.00	.0546	180.	3.93	.0218	227.	60.
47	MC	70.	2.50	.0357	180.	3.79	.021	157.	41.2	110	MC	50.	3.00	.06	162.	3.72	.023	224.	61.7
48	MC	17.	3.00	.1765	32.	3.64	.1138	88.	35.5	111	MD	102.	7.75	.076	140.4	7.75	.055	36.6	27.6
49	MC	35.	2.00	.0572	73.	3.01	.0412	108.6	38.8	112	MD	12.9	19.50	1.51	24.5	26.16	1.07	89.9	41.1
50	MC	49.	2.25	.046	90.	3.39	.0377	83.7	22.0	115	MD	45.3	7.25	.16	95.	10.35	.1089	109.	31.3
51	MC	34.	2.50	.0736	73.	3.87	.053	114.	28.	116	MD	33.33	13.71	.4113	65.37	13.07	.1997	90.3	51.4
52	MC	73.	2.50	.0343	190.	3.64	.0186	160.	45.7	117	MD	8.66	3.01	.347	16.	3.01	.188	86.	45.8
53	MC	75.	3.00	.04	550.	4.05	.0074	633.	81.5	118	MD	90.	3.24	.036	316.	4.55	.014	251.1	61.1
54	MD	79.	11.25	.155	166.5	16.666	.10	110.7	35.4	119	MD	91.	12.04	.132	127.75	8.04	.063	40.3	52.2
55	MC	43.	5.25	.122	77.	7.37	.0958	79.1	38.2	120	MD	91.	11.26	.1237	162.	9.41	.058	78.	53.1
56	MC	65.	1.39	.0214	325.	1.93	.0059	400.	72.5	121	MD	242.	12.34	.0509	435.	9.35	.0214	79.7	58.
57	MC	65.	1.39	.0214	360.	2.02	.0056	454.	73.9	122	MC	160.	2.02	.0125	700.	4.73	.0067	337.	46.4

Selection of Electric Motors and Controllers

When to Use Alternating or Direct Current—Size and Type of Motor—Proper Type of Control

By S H Libby

THE selection of electric motors and controllers for foundry use presupposes the selection of the proper kind of electric energy to suit conditions, and while alternating current is in many cases as well adapted for foundry work as direct current there are places in which the direct current motor has a distinct advantage over the alternating current. As a study of the different uses to which the motor is to be put will best show the requirements, we will investigate the requirements for crane motors, and assume first that direct current is available. The voltage at our conductors is, of course, immaterial as far as operation of our motors is concerned, but should preferably be 230 volts, as at this voltage insulation is not as hard to maintain or the danger as great as at 500 volts, and the cost of copper in the conductors is appreciably less than if 115 volts were used. In all probability there is nothing as indefinite about a crane or hoist as the rating given to the motors by the various crane builders, one size frame, for instance, being rated at any point between 5 and 15 horsepower.

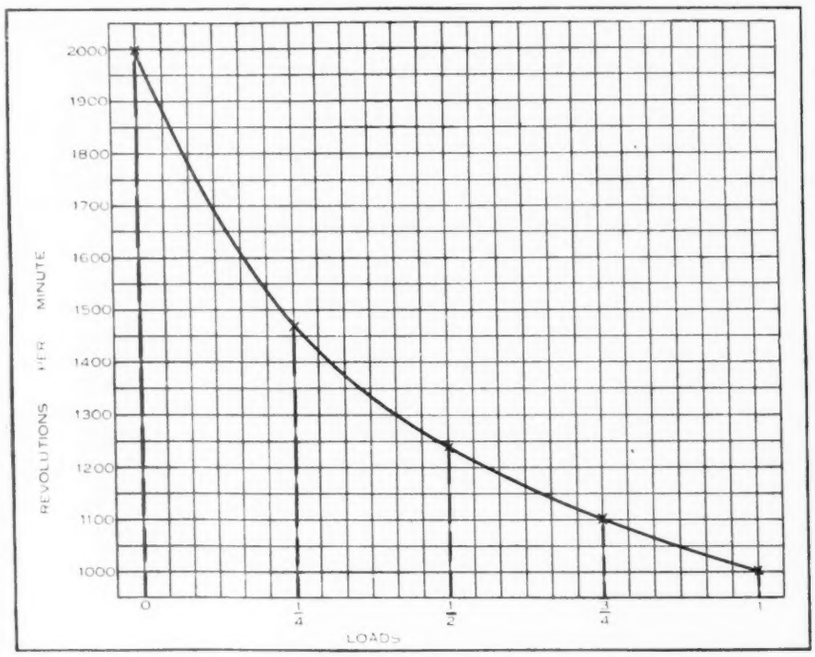


FIG. 1—CHARACTERISTICS OF TYPICAL CRANE MOTOR

As ordinary crane service is far more intermittent than the duty in the majority of cases where electric motors are used, the motor may, of course, be rated higher than if used for other duties. For ordinary crane work it has been found that a rating based on a half-hour run with a rise in temperature not to exceed 55 degrees Cent. is conservative.

For ordinary uses the speed of the apparatus has little to do with the selection of the motor, but for hoist duty, particularly where patterns are to be drawn or copes lifted, the results to be obtained depend to a very great extent on the proper selection of the motor and control. As it is possible to handle light loads at much higher speeds than heavy loads, the empty crane hook should be capable of being raised or lowered at a much greater speed than the full load speed, thus effecting a saving of time and increasing the efficiency of the cranes. Years of experience appears to indicate that a no load speed of double full load speed is very satisfactory, and easy to obtain with a properly designed motor.

In considering the hoisting and conveying of material, we find that the duty is analogous to railway work in that the motor must start and accelerate under full load, and for that reason the same type of motor is desirable, that is, a series motor. For our hoisting and conveying, the series motor is not only well adapted on account of its high starting torque and simplicity of control, but also on account of its tendency to speed up under no load, resulting in an increased speed of the empty hook, thereby reducing the time required to complete a given cycle of operations.

If the motor is so designed as to give a no load speed of double that of full load, the high speed will not be so great as to result in damage to its rotating parts, and if it is correctly proportioned magnetically and otherwise, the highest peripheral speed will not be dangerous.

Fig. 1 shows the characteristics of a typical crane motor, the speed of the armature being plotted against the load on the hook. It will be noted that while the full load speed of this machine is 1,000 revolutions per minute the three-fourths load speed is 1,100 revolutions per minute, the curve showing a fairly straight line and nearly equal increase in speed from full load to one-half load, but at a point between one-half and one-fourth load the direction begins to change until that portion of the curve lying between one-fourth load and no load has become more nearly vertical and the change in speed is much more rapid than the change in load. This curve is taken from the characteristic curves of a line of crane motors which have proved very successful in service, from the operations of which our deductions have been made. The crane motor should also combine another of the characteristics of the railway motor in that it must be weatherproof, thus insuring the protection of its interior from the moisture and fine dust so prevalent in foundries. For this reason the doors should fit motor brackets by means of machined joints. Crane motors should also, like the railway motor, allow of the fixing of the brushes at one point and the reversal of the motor without undue sparking.

An analysis of the requirements in foundries indicates that two general types of control are necessary, one for handling flasks in the flask yard, or for handling coal, coke, pig and sand;

A paper read at the Chicago meeting of the American Foundrymen's Association.

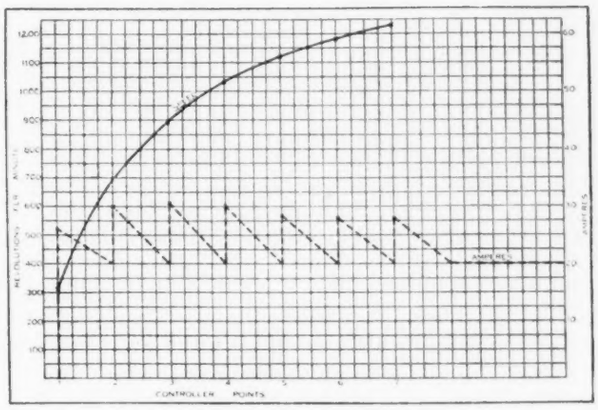


FIG. 2—SPEED AT ONE-HALF LOAD ON SEVEN POINT CONTROLLER

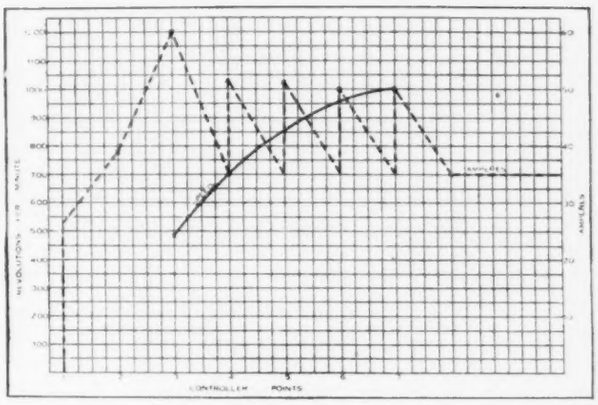


FIG. 3—CURRENT AVAILABLE FOR ACCELERATION

while the other is for use in the molding shop for drawing patterns, lifting copes, and pouring off. If these two requirements may be satisfied with one controller combining the two types, the problem is simplified. For the first type a rheostatic controller will be sufficient. Such a controller should allow of lifting half-load on the first notch, at one-quarter to one-third full load full speed. This will mean an arrangement of resistance which will allow of 75 per cent of full load current flowing on first notch when motor is at a standstill. Such an arrangement will give sufficient allowance for overcoming the starting friction of the entire machine and also for acceleration.

Fig. 2 is plotted to show the speed of one-half load on the various notches of a seven point controller, from which it will be noted that the approximate full load speed is reached at the fourth notch. This curve also shows the rush of current as the controller is turned to each successive point, the lower point of curve denoting the running current for half-load, the difference between that point and the upper point denoting the current utilized in acceleration. Taking full load which requires approximately 35 amperes, we find that it could not be started on the first notch, as the maximum current on that step is only 26 amperes. Turning the controller to the second point gives a current of 39 amperes and as the running current is 35 amperes the difference of four amperes is not enough to overcome the static friction and accelerate the load, and the controller must, therefore, be turned to the third point. A reference to Fig. 3 shows that the first rush of current on this point is 60 amperes, leaving 25 amperes to start and accelerate. This curve also shows the current on the different points which is available for acceleration. From these curves we find that a variation may be obtained from half-load at about quarter speed, to full load full speed, which variation is entirely acceptable for crane work falling within our first requirements, but it would be entirely inadequate in fulfilling our second requirements.

Suppose, for instance, it is desired to draw a pattern which may reasonably be expected to weigh at most not more than one-fourth of full load, the results if the attempt is made with our rheostatic controller are shown in Fig. 4, where our slowest speed is more than 75 per cent of full load full speed. It will probably be said that the first point of resistance may be so changed as to allow of handling light loads at slow speeds. This is true, but in changing to accommodate the light loads we have spoiled its use for half or similar loads.

Assuming a required starting current of 33 per cent over the running current, and one-fourth load to lift, our current at start must be 18 amperes and drop to 13 amperes at the end of the accelerating period, and with resistance so arranged as to produce those results half-load could not, of course, be started on that point, and it would, therefore, be necessary to use the second point for starting that load, thus adding another point to our controller. One-quarter load, however, is a rather heavy allowance for the pattern in most cases so that we should be able to handle a still smaller load on the first point, say one-eighth load.

One-eighth load would require approximately seven amperes running current and 9.5 amperes to start, including acceleration. This would mean that one-fourth load must start on the second point and one-half load on the third point, thus adding two points to the controller and making it necessary to "feel" the controller along until the

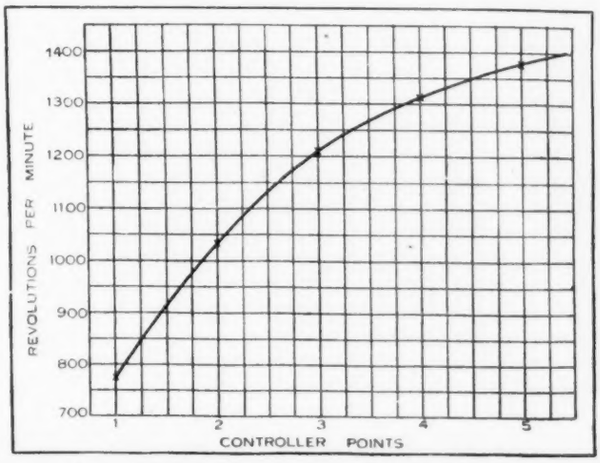


FIG. 4—SPEEDS WITH ONE QUARTER LOAD

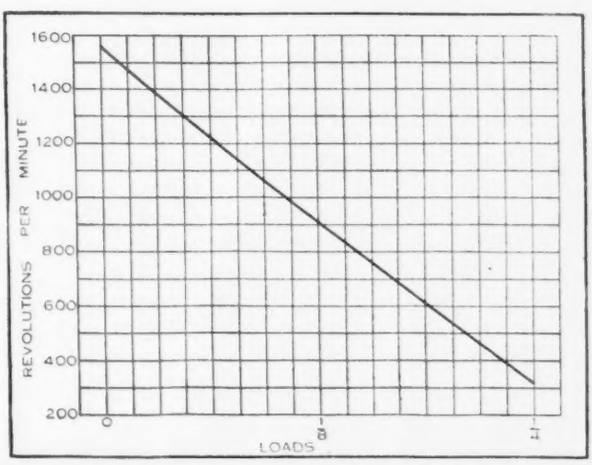


FIG. 5—SPEED VARIATIONS WITH RHEOSTATIC CONTROL

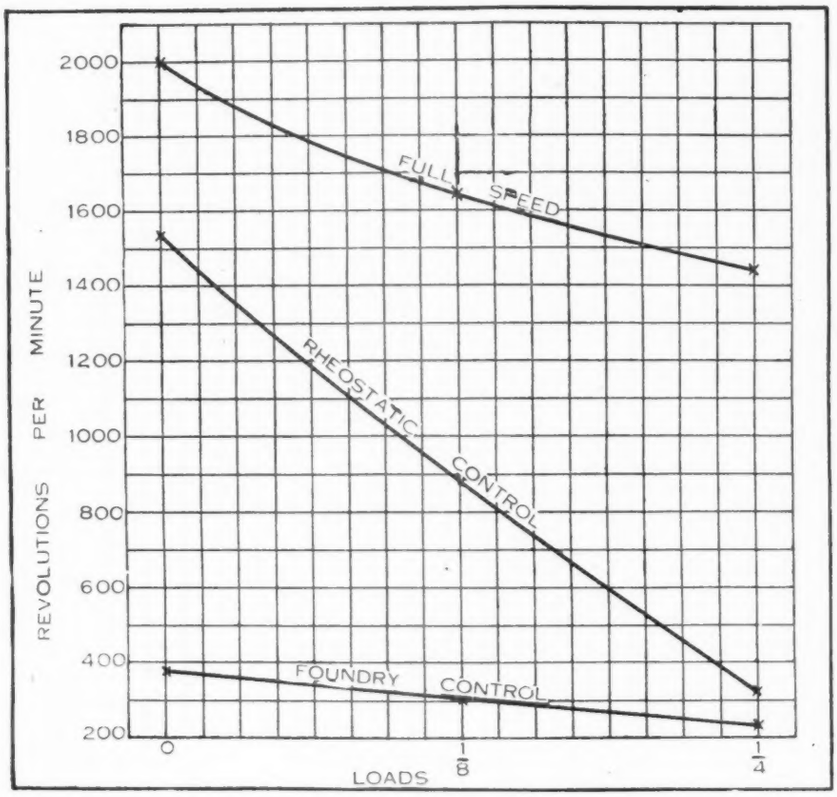


FIG. 6—FOUNDRY CONTROL AND RHEOSTATIC CONTROL CONTRASTED

point at which the load will start is reached.

This not only results in a cumbersome controller, but in a loss of time if the molder is also the hoist operator, as in the case of light work with floor control, where the hoist is intended as additional equipment in the molder's hands to expedite his work. Again, the great variation in speed on the same controller point, with a change in load, may result in bad work, not only on account of too high speed for drawing patterns and lifting copes, but also on account of the sudden increase in speed as a sticky flask becomes free. Fig. 5 shows what may be expected of rheostatic control when such a change in load occurs. This curve shows the speed of smaller loads when run on a controller point designed to give one-quarter speed at one-quarter load.

It is very evident that the rheostatic controller is not the ideal controller for use in the molding shops, particularly because it does not give a sufficiently constant speed with a wide range of load on the first notch, and we must therefore find something which will show different characteristics. What is desirable then is a controller which will approximate as nearly as possible on the first notch the constant speed characteristics of the shunt motor, and yet retain the series motor characteristics on the other points. With a properly designed motor this may be accomplished by arranging a resistance in shunt with the armature in addition to a series resistance.

Fig. 6 shows the characteristics of such a motor for so-called foundry control and also for rheostatic control.

It will be noted how much flatter is the curve for "foundry" than for the rheostatic control, showing comparatively little change in speed from one-quarter load to no load. This comparatively small change in speed is, of course, desirable for it means that in drawing a pattern which weighs one-eighth of full load this speed would only be 60 per cent higher than if the weight was one-quarter of the full load. Or, to put it still plainer, if the speed at one-quarter load were two feet per minute the speed with one-half of that load or one-eighth full load would be 3.2 feet per minute, not a prohibitive speed and one easily controlled, as the operator has only to turn the controller to the first point and he gets the proper speed for all loads within a wide range without juggling the controller.

In this particular class of work the direct current motor shows its superiority over the alternating current as a glance at Fig. 7 will indicate. On this curve it will be noted that we are starting at a point at which one-quarter load may be accelerated and that at that load the speed reaches 300 revolutions per minute. If, however, the load is one-eighth of full load the speed will reach about 750 revolutions per minute, or more than twice the one-quarter load speed. A comparison of the two curves as to angle with the base line discloses this graphically, both curves being drawn to the same scale.

For other than crane duty the general requirements appear to be similar to those obtaining in certain heavy tool operation, such as planers, punch presses, etc., and motors which would best meet such requirements should prove satisfactory for foundry work.

One characteristic which such motors should have in common with the crane motors is that of being totally enclosed, as in spite of any method of boxing or housing which is generally in vogue in foundries, the fine dust permeates to the motor and invariably results in more or less trouble. For general use on tumbling barrels, sand carriers, mixers, etc., a compound wound motor with a series field of 10 to 15 per cent should be used if direct current is used, as the characteristics of such a motor would enable it to keep

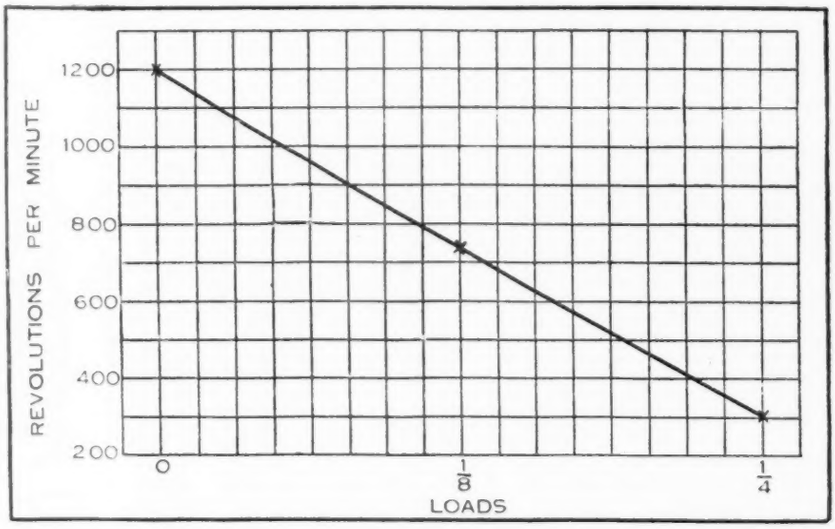


FIG. 7—ALTERNATING CURRENT MOTORS WITH RHEOSTATIC CONTROL

the apparatus in motion under heavy overloads without any bad results at the commutator. Such a motor would also start a heavy load, to which it might be direct connected, such as tumbling barrels or sand conveyor, with the same absence of commutator trouble.

If alternating current is being used a slip ring motor should be specified, as such a motor will be capable of gradually starting such machines as may be loaded although not running.

In selecting motors for the general uses above described, a mistake as to the size should be, of course, avoided, and it is quite as much of a mistake to select a motor which is too large for the work as to select one that is too small. The small motor would, of course, burn out, necessitating repair or replacement, while the large motor would not only be expensive as to first cost, but inefficient while running at small load. In selecting controlling devices much will depend upon a careful study of the actual conditions, as a control which would be satisfactory in one case might prove entirely inadequate in another.

For instance, if a machine is to be started and stopped frequently as would be the case of a lathe or planer, an automatic or push button control, of which little is generally known, would prove to be a good investment, in spite of the seeming high first cost. Such a control not only eliminates the results of carelessness or ignorance on the part of the operator, but also has the added advantage of safety in the event of failure of current, as under such conditions everything goes to "off" position and the full cycle of operations must be performed again before the motor can be started.

For ordinary uses, however, where a machine is started but a few times each day, the simpler form of controller is satisfactory. As an auxiliary equipment for motors of 25 horsepower and above, an ammeter has been found to be of considerable value in detecting increased load due to lack of lubrication, to faulty adjustment of the driven machine, or to a tendency of operators to overload the machines. Such a device would also show if the motor was too large or too small, and so allow of a change in the equipment to give better results.

From the foregoing it may be seen that each problem must be carefully studied in order that a proper decision may be reached as to: (a) The selection of alternating or direct current; (b) the type of motor; (c) the type of control, and (d) the size of motor. Without such study the results are sure to be anything but satisfactory.

Opportunities for the Foundry Engineer

By W F Prince, M. E.

IN THE past few years, foundry practice has made tremendous forward strides, but present indications point to even greater advances in the future. It is my firm belief that some day it will be possible to mold 1,000 12 x 14-inch flasks per man per day. I believe the day is coming when sand will be elevated to a given height and dropped in a cartridge form into a flask and the speed of such molding will depend on the rapidity of our being able to drop a cubic foot of sand and get the mold away. This is not a dream, as I have found it to be practical. I have elevated sand to a height of 50 feet and have compressed it into a cubic foot, just enough to hold it together. I then have dropped the sand and find it strikes a blow of about 40 pounds to the square inch and rams a mold satisfactorily. The castings coming from such a mold were good. The speed of such molding will depend on the ability of foundry engineers to equip and take care of the material used and the output.

Consider also the question of melting. The writer has been experimenting with a furnace 24 inches inside diameter, with an opening through the wall to allow an oil flame to do the melting. In order to know how hot a flame I could get I placed a one-inch wrought iron rod in the center of this furnace. As I turned on the air or oil I could see the different colors on this rod. I found when I got the rod to a certain white heat it would stay there until by turning the air or oil valve very slightly, I could start the rod to melting in about a second; with slightly more oil I could check its melting; with a little too much or too little air I could change its condition or move the rod to a different position. In fact, the slightest change would change the melting conditions in the furnace from good to poor. In the light of this fact can we believe it possible that hundreds of years ago foundrymen hit upon the right principle in melting? This principle apparently allows us to have obstructions of all kinds in our cupolas, leaky pipes, slipping belts and clogged tuyeres, and while we can and do melt under such conditions, we do it at great cost, and I believe here is a chance for the scientific engineer to work advancement in practice.

Iron molding sand is composed approximately as follows:

	Per Cent.
Volatile or organic matter.....	2.50
Silica	81.00
Alumina Oxide	9.00
Iron Oxide	5.00
Calcium Oxide	1.00
Magnesium Oxide	.50

Now, the silica and the organic matter we can get in most any sand. I have found that the principal ingredient we are after is alumina. We find this in different quantities and I believe the life and value of molding sands depend largely on this alumina. I find this to vary from approximately 1 to 12 per cent. Would it be too much to imagine that some day some one would find a way to treat sands and give to us a standard amount of alumina?

We throw away each year thousands of tons of molding sand because it is old, and we say it is burned out and has lost its bond. In some cases this is so, but in many cases I find it is not so and an analysis of this sand will show that the alumina and in some cases the vegetable bond is not gone. In such cases this so called old sand has simply taken on a coating or film of carbon which encircles or encrusts each grain of silica and as it is not soluble in water, it does not allow absorption to take place. Therefore, the film of bond cannot get at the silica to get a hold.

The bond in molding sand acts like the plaster on a brick. The pores of the brick absorb the moisture and draw in a thousand little hairs of plaster. These small hairs harden and form the bond. So with our molding sands. They must have clean surfaces to allow this absorption to take place. This cannot take place as long as a film of carbon encrusts the grains of silica. I have made some experiments and I find that if this so-called old sand is put into a pan mill and ground with a sharp sand or fine rock it will again become serviceable.

I once received a carload of gravel and in unloading it by a belt conveyor I found it contained a lot of small white stones about the size of a marble. I put some of these into a mill and crushed them to a powder. I

Abstract of a paper read before the Philadelphia Foundrymen's Association, Jan. 6, 1915. The author, W. F. Prince, is a consulting foundry specialist, 30 Church street, New York.

then added about three times the same quantity of old burned sand from the cleaning room and ground the mixture together, with enough water to make a mud. With this mud and without any other bond, I made a core as hard as a rock. In this case, the sharp, fine rock ground and cleaned the sand and the water and finer particles made a bond.

Bonding Core Sand

There is a principle involved in bonding and baking of core sands that is interesting. Core sand is held together by a vegetable bond. As little as possible should be used because if the gases are not taken care of, they will pass up through the metal and cause segregation of sulphur. If too much is used it does not carbonize, but remains soft and pasty. It therefore does not give strength unless an excessive amount of heat is applied.

In times gone by flour and meal were used in a ratio of about 1 to 15. Today we have advanced and find it possible to use oils, pitches, syrups and other vegetable products and in some cases mineral oils and fish oils. The proper drying or carbonizing of the bond is very important. The principle is the same as baking a loaf of bread in an oven. The heat should bake, crust or carbonize the bond. We want the same action to take place in forming the crust on bread.

I have always considered sulphur one of the most trouble producing elements. One day a piece of iron was brought to me that contained a quantity of kish. It had been cut from a water pipe made in loam and cast on end. On analyzing it I found it to contain a large amount of sulphur. I also drilled a hole in the clean iron just under the affected spot and found it to be very low in sulphur, 0.02 per cent to be exact. It appeared as if something had collected the sulphur and drawn it up to the bad spot, which I believe was due to the boiling of the mold. I therefore took a ladle, put a hole in the bottom and connected it with an air hose. I then turned on the air and tapped the iron into the ladle.

I boiled the iron for about ten minutes and considerable kish rose to the top of the ladle where it was skimmed off. On analyzing the metal I found this process had taken out about 35 per cent of the sulphur. I have made hundreds of tests of this character and I find I can at will take out from 25 to 50 per cent of the sulphur.

I have found that sulphur causes many troubles that are otherwise difficult to explain. We cast a large condenser and the top flange shrunk badly and contained a large amount of kish. On analyzing the flange it was found to contain 0.196 per cent sulphur; the bottom flange contained 0.084 per cent sulphur. The boiling process described had taken place in the mold and had caused the sulphur to rise to the top.

Shrink holes in walls are often full of kish. Spongy castings and hard castings from seemingly soft mixtures are caused by a similar agitation that robs the sulphur from one spot and delivers it to another.

In order to accomplish this we should appreciate the necessity of having the right sand, the right bond, the right amount of bond and the correct temperature in the ovens. Here is fertile field for the scientific engineer to cultivate.

I once made a casting, 14 inches in diameter and 10 feet long with a thickness of 3 inches. It was cast in dry sand, and on the end. On this piece I cast 16 test-bars at different locations and I found the physical results varied from 5 per cent elongation to 16 per cent elongation. A test-bar taken out of the riser at the very top of the casting showed the best elongation. On a large cylinder, weighing some five tons, were cast 12 bars and each bar showed that the specifications were not met, but a section cut out of the casting gave 21 per cent elongation, while the test bars did not give an average of over 10 per cent. Again, a flat plate 1 inch thick, 12 inches long and 6 inches wide, was cast in a dry sand mold, then cut into four strips and tested. These four bars, out of the same metal and the same plate, showed different variations as follows:

	Tensile strength, pound per square inch.	Elongation, per cent.
No. 1 bar.....	33,150	10
No. 2 bar.....	22,350	11½
No. 3 bar.....	34,700	15
No. 4 bar.....	38,200	15

This same metal, out of the same ladle, cast into a solid block 6 x 6 x 12 inches, with a test-bar cast on each side showed a variation of from 4½ per cent elongation to 9½ per cent elongation, and this same metal cast into a test-bar alone, in a flask, showed a tensile strength of 33,700 pounds with an elongation of 16 per cent.

Hundreds of such tests convince me that meeting specifications requires more thought in locating test bars and the style of the test bar than does the mixture. I believe thousands of tons of castings have been condemned on the failure of the test bars. The test bars did not represent the physical conditions of the castings, and I believe castings show the same conditions as do test bars, should we cut them up and use the different sections for tests. Here we can see a lifelong study for the scientific student. The engineer will find equally as many problems to solve in diagnosing and operating foundry machinery as he will in a machine shop or factory. Machinery must do the work now done by muscle. Man's physical strength cannot keep pace with advancement.

Development of Permanent Molds

I want to say, as a practical foundryman, that I believe the making of castings in a permanent mold has merit, that there is a field for its use, and if we all would throw off the conservatism which we seem to be heir to and lend to this process our assistance, we could find a great use for it. Some of us say it combines the carbon, that it cuts out in constant use, and that it has other drawbacks. I say, sulphur combines carbon and that I can take a part of this sulphur out of iron, also a part of the manganese. This, then, is one step toward improving the conditions. Does it seem impossible for us to find a way to overcome some of its other seeming objections? I have used one of these machines, have made a study of the principle involved, and can see a future for such molding. It is passing through the period all improvements have to go through.

The Independent Pneumatic Tool Co., Chicago, manufacturer of pneumatic tools and electric drills, has appointed V. W. Robinson, Michigan representative with headquarters at Detroit. F. J. Passino, formerly Michigan representative, has been appointed representative in the southwest to succeed H. F. Finney, who was promoted to a position in the general sales office in Chicago.

The Ingersoll-Rand Co., 11 Broadway, New York, has recently issued two new catalogs, Nos. 3024 and 3030, on the Ingersoll-Rogler air compressors. Catalog No. 3024 is a complete treatise on the Ingersoll-Rogler valve and No. 3030 covers the class ER-1 type of compressor manufactured by this concern. Both catalogs are profusely illustrated.

The Debevoise-Anderson Co., 56 Liberty street, New York, has opened a New England office in the Exchange building, Boston which is in charge of C. A. Wyatt, formerly of Rogers, Brown & Co. The company will offer Buffalo, eastern Pennsylvania and Virginia pig iron, as well as foundry, smelting and crushed coke.

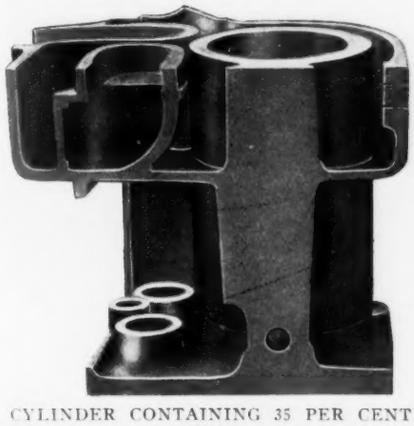
The Hill-Brunner Foundry Supply Co., Cincinnati, is sending to the trade a handsome wall calendar.

Teaching Foundry Practice by Mail

An Analysis of an Interesting System of Foundry Education That Deals With Practical Subjects

Air Cooled Semi-Steel Cylinder

HOW CAN I make better castings for less money? This question sums up the one great desire of the foundryman of today. It voices an ambition that applies with equal force to the properietor or the humblest piece worker; to the latter it spells emancipation from the sand heap, greater rewards, increased self-respect and more of life's comforts; to the proprietor, the manager or the superintendent it means more profit, greater prestige, increased capacity for service and a larger place in the world of affairs. And foundrymen have found out there is but one method to follow in order to make better castings for less money—namely through education and by acquiring the information, power and ability to achieve that practical education brings. Therefore, we now find a greater thirst for knowledge in the foundry industry than ever before; the tremendous strides of the past 20 years seem but to have set men to thinking and opened their eyes to the possibilities of a future which can be unlocked only by a more accurate and comprehensive knowledge of the laws of nature.



CYLINDER CONTAINING 35 PER CENT STEEL

How is this demand for practical, up-to-date foundry education being met? What provisions have been made within the industry and outside of it to give definite, helpful instruction to the younger men in the business, and practical dollar-producing information to the older heads? These are questions in which every progressive foundryman is interested. It is not the purpose of this article to furnish a comprehensive answer, but simply to point how in one way the demand for foundry education is being supplied, with unusually interesting results.

Semi-Steel

The characteristics of semi-steel are too well known to the readers of THE FOUNDRY *to require detailed explanation. This article describes a system of foundry education, an important part of which is devoted to methods for producing high-grade castings containing from* 10 *to* 50 *per cent steel in the ordinary cupola. Considerable controversy has raged about the name "semi-steel" and nearly every foundryman has heard the cry, "semi-steel is a misnomer." This, however, is not a criticism of the product itself, but refers to the term "semi-steel". The beneficial results which accrue from the addition of steel to cupola mixtures are generally recognized at the present time, and in the last analysis the name of the resulting metal is of minor importance.*

The five principal agencies through which foundrymen are being educated are as follows: The trade paper, the technical society, the vocational school, the college or university, and the correspondence school. The latter is sometimes called the extension method, because it extends the teaching of the master craftsman right down to the man in the shop regardless of where he may be located. Each of these means of education has its own particular field, and they all can and do flourish side by side, one supplementing the other.

The correspondence school, however, is the most picturesque of the five, the most unique in its methods and results, and it is with the correspondence system of instruction that this article is concerned. The position of the correspondence school in the general scheme of education is analogous to that of the moving picture in the amusement world. It is universal in its appeal and achieves results which cannot be obtained through other agencies. In a general way, the rapid growth and tremendous success of the correspondence school idea in the United States are too well known to require comment. It has been particularly successful in the foundry field and has been the means of bringing independence and financial success to many foundrymen who, otherwise, never would have been able to climb out of the mediocre class. The place which this institution has won for itself in the field of foundry education can be set forth to best advantage by studying the operations of a particular school. For this purpose, McLain's System, founded and operated by David McLain, Milwaukee, is particularly interesting because McLain was a pioneer in this field and his organization today stands prominent among the many institu-

DAVID McLAIN

tions in this country devoted to technical education.

McLain's System is a method of instruction by correspondence for practical foundrymen, which aims to cover the metallurgy of the foundry in a simple, straightforward and practical manner. The system is designed to teach the foundryman how to buy pig iron on specification and make up cupola mixtures by analysis; how to arrange any cupola to melt iron scientifically; how to make semi-steel using 10 to 50 per cent steel scrap in the regular cupola; how to make chill castings without the use of charcoal iron and how to make stove plate, architectural and other light castings without the use of high silicon pig.

WHERE THE CORRESPONDENCE IS HANDLED

The information embodied in the system is arranged in a series of 12 relatively short printed lessons which are sent to the student, together with 12 question papers. The lessons are studied in regular order and the questions are answered and sent to the school. Where difficulties are met, the student receives individual advice, and he also has the benefit of individual advice regarding his particular foundry problems. Further details on this point will be given later. The course aims to reach foundrymen who desire to put their melting practice on a scientific basis and also to teach molders and other foundry employes how to melt iron and run a cupola so that they will be fitted for higher positions. In other words, the principal qualification for enrollment is a connection with or interest in the foundry business. No previous preparation, other than a knowledge of the English language, is necessary. It should be stated that McLain's System aims to cover only the melting department and the points outlined above; no effort is made to go into the details of molding or coremaking in the lessons, although advice on these points is given frequently in connection with some particular difficulty.

The Advantage of Scientific Melting

It hardly seems necessary in this connection to call attention to the greater success open to the foundryman who handles his melting in the light of scientific facts and principles such as are imparted by a definite, reliable system of instruction, but it might not be amiss to point out the results actually obtained by one foundryman through improved cupola practice. This foundryman's records show that in December, 1913, he melted 133,500 pounds of iron with 23,500 pounds of coke, the ratio being 1 to 5.7; in April, 1914, after a course of instruction by correspondence, he melted 277,100 pounds of iron with 27,370 pounds of coke in the same cupola, the melting ratio being 1 to 10.1.

The multiplication of incidents of this nature makes plain the character of the position occupied by the correspondence school in the general scheme of foundry education. McLain's System is the natural outgrowth of conditions which have existed in the foundry business. In the old days, the foundryman graded his pig iron according to fracture and therefore made up his cupola mixtures by guess work. A little over 20 years ago, Mesabi ores began to assume importance and the furnace companies called in the aid of chemists to help them use the new raw material. Up to this time all the pig iron ran very even, and when a mixture for a certain class of work was made, it was merely necessary to order the same brands of iron year after year. After the chemist got through with the ore and iron, all this was changed, but the foundryman did not know it. He went on ordering the same as before, with the result that if he did not know how to mix by analysis, he got into trouble and he is still in trouble today for the same reason if he does not know how to make mixtures scientifically.

DICTATING PERSONAL LETTERS TO STUDENTS

It was with the object of meeting this need for accurate information regarding the metallurgy of pig iron and scientific cupola practice that Mr. McLain established his system. It might be stated here that it is not necessary for a foundryman to be a chemist, but it is necessary for him to understand enough of the rudiments of chemistry to appreciate the effect of the various elements, carbon, silicon, manganese, sulphur and phosphorus, in pig iron. In order to be

successful, the foundryman must know what his pig iron contains and this means that he needs the chemist in his business. The chemist, therefore, has profited materially through placing foundry melting practice on its proper basis.

McLain's System was established in February, 1908, as a result of the causes outlined above, after its founder, David McLain, had spent 35 years in the foundry business, occupying all grades of positions from molder to manager. As in most other institutions, the initial growth was slow and during the first year 48 students were enrolled. Gradually, however, progress became more rapid and up to date the course has been taken by over 2,000 students located not only in the United States, but in all portions of the civilized world. Approximately 75 per cent of the students are managers and owners of plants, although the course, at the beginning, was designed for the practical man in the shop. As the teachings, however, run counter in many points to practices that have been followed in the foundry for years, the man in the shop with his traditional conservatism has been a little reluctant to take advantage of the opportunity; but to the manager and owner it appears purely as a business proposition in which so-called practical considerations do not enter. From the statement that the system aims to cover the successful production of semi-steel in a thorough and comprehensive manner, it should not be inferred that ordinary gray iron foundry practice is neglected. As a matter of fact, the bulk of the information in the lessons is devoted to iron foundry work.

As mentioned above, the course is divided into 12 lessons. Every effort is made to have the information contained in the lessons condensed and at the same time complete and presented in a clear and understandable manner. The actual character of the instruction may be best judged from the following synopsis of the points covered in one of the lessons on cupola practice. This paper takes up the selection of a cupola of a suitable size; the selection of the fan or blower; the effect of operating the fan in a vacuum; the factors which make each cupola a separate study; the proper arrangement of the blast pipe; the operation of the blast gate; the effect of high and low blast; the loss of metal by oxidation; the proper way to lay the bricks and blocks in the cupola; methods of repairing the lining; the proper tuyere area; the proper height for tuyeres; the use of upper tuyeres; the method of daubing and making up the cupola breast; the proper size of tap hole; the height of the charging door; the method of lighting up; proper and improper charging; details of the first charge and the charges of iron after the bed charge; the method of procedure for melting 12 to 15 pounds of iron to one pound of coke between charges; how to calculate the weight of coke necessary to raise the bed charge to the right height; how to estimate the number of pounds of iron that may be melted per pound of coke when the per cent of carbon in the coke is known; the use and abuse of limestone; the proper location of the melting zone; the remedy for slow melting; the method of melting different grades of iron in one heat; the method of avoiding pin holes and bridging; the amount of air required per ton; the use of fluxes; rules for figuring areas, etc., etc.

A CORNER IN THE GENERAL OFFICE

GIVING SPECIAL ADVICE ON A KNOTTY PROBLEM

The question papers are planned to cover the principal points in each lesson thoroughly. For instance, some of the questions which accompany the sixth lesson are as follows:

Give the analysis of good pig iron for ammonia castings.

What percentage of manganese would you advise in general jobbing castings?

Would you advise lump ferro-manganese, or high manganese pig?

What function does manganese perform?

State the limits of silicon for stove plate.

Should light steel clippings be charged loosely?

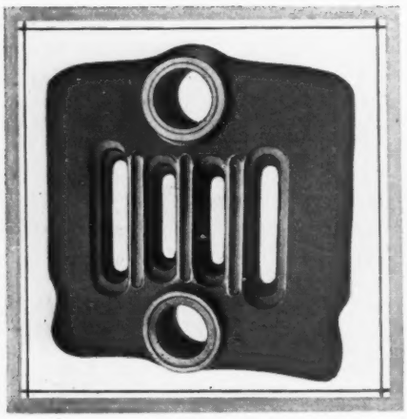
How would you advise the use of borings and turnings?

Should water backs and fronts be poured of stove plate iron?

How much does your soft iron shrink per foot?

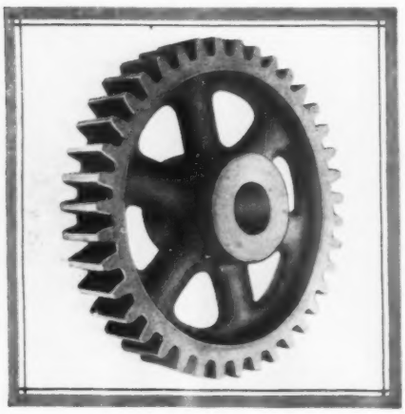
If coke is wet when received, what should be done?

The individual advice which the client receives is perhaps as important as the information conveyed by the printed lessons and question papers. An effort is made to get in close touch with the student's shop practice. He fills in a blank, giving the nature of his casting troubles and every effort is made to see to it that



SEMI-STEEL RADIATOR SECTION

he applies the information he obtains to his particular class of work, in order that he may satisfactorily overcome his individual shop difficulties, save money on the purchase of materials, cheapen his mixtures, and make stronger and better castings. All of the letters and question papers returned by the students are examined by Mr. McLain personally, and the outgoing mail is checked by him. Each client is furnished with a cupola schedule, which he fills out, giving full data in regard to the arrangement of his cupola, his method of charging, total time of heat, weight of iron and fuel used, etc. With this information in hand, McLain's System is in a position to give the student individual advice, including, for instance, data on the proper size of tuyeres, arrangement of the blast pipe, speed of fan or blower, height of bed, size of charges for both iron and coke, height of charging door, proper blast pressure, etc., in order to get the most satisfactory results out of the particular cupola under consideration. This individual contact with the student does not end with the completion of his course, but continues indefinitely. In many instances, the correspondence continues for years. One foundryman in California, for instance, addressed 22 letters to Mr. McLain

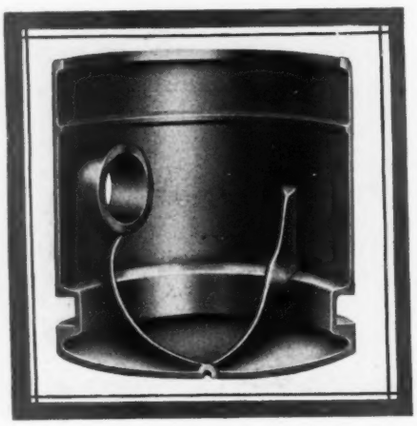


SEMI-STEEL GEAR

in the course of a couple of years, each one covering some particular feature of his practice which he wished to discuss and clear up. Some idea of the nature of the inquiries and the replies may be gathered from the following extracts from a letter from another student on the Pacific coast. This man wrote as follows:

"Enclosed you will find answers to questions in the semi-steel lesson. * * * * * What is the difference between air delivered to the cupola by volume or by pressure? Is there any pig iron high enough in manganese to make semi-steel without the use of ferro-manganese? Can you use cast steel scrap, sheet iron, old rail, clippings and punchings, or any kind of steel scrap to make semi-steel? Let me know if you think I understand this lesson."

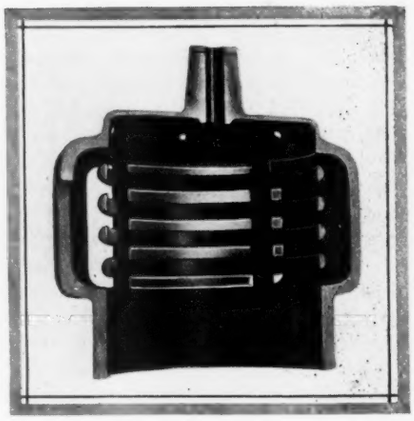
The reply, which was sent within a few days, contained, in addition to



AUTO PISTON CONTAINING 20 PER CENT STEEL

other information, the following answers to the questions quoted above:

"Melting by volume means sufficient tuyere area to admit air as it is delivered. High blast will oxidize carbon and silicon, converting silicon to silica, its oxide, which runs to slag. Your No. 1B pig iron is sufficiently high in manganese to do away with the use of ferro-manganese in making the castings you mention. Use your semi-steel scrap. One-third No. 1B pig iron, one-third semi-steel scrap and one-third steel scrap will produce a suitable metal for large gears. In making semi-steel for different-sized castings, good judgment must be used and the instructions must be applied to fit your local conditions. You are the man on the job and it is up to you to make good. You can use cast steel scrap, old rails, punchings, boiler clippings, but no rusty sheet iron, in the work you mention. You can use the clippings and punchings from the car scrap of the analysis you mention and the analysis of the rail steel scrap is found in the lesson. Boiler clippings and shearings are of the same grade as boiler punchings, which are very good for making high-grade semi-steel automobile cylinders. When making semi-steel for heavy sections, old rails or structural steel scrap or heavy steel castings may be used. Nearly all of the questions you have



AIR MIXER FOR GASOLINE ENGINE CONTAINING 30 PER CENT STEEL

asked are answered in the lesson, but they got by you."

The results obtained from the McLain System are no different than those which accompany any other efficient or practical system of education. They may all be summed up in the answer to the question which appears at the beginning of this article, "How can I make better castings for less money?" This knowledge brings with it frequently a new attitude of mind on the part of the student and a new conception of the dignity and possibilities of his position. No system of education can accomplish lasting results by a mere wave of the hand. The foundryman who wishes to learn more about his business must approach the matter with the proper attitude of mind and with the determination to co-operate to the limit of his ability with his instructor. A receptive spirit and a willingness to develop thinking power are necessary for complete success. The best teacher cannot give a man a new brain, but even the poorest can be of immeasurable benefit to a progressive mind, while an efficient system of instruction brings the ambitious man to the threshold of unlimited progress.

LOCOMOTIVE VALVE CONTAINING 45 PER CENT STEEL

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Mushroom Gates and Risers

We experience some difficulty in making bushings weighing 150 pounds each. Externally the castings are smooth, but when machined blow-holes develop. The mixture consists of 100 pounds of copper, 10 pounds of tin and 10 pounds of lead. After the castings are poured, the gates and risers swell practically 1½ inches higher than the top of the flask. What is the cause of this phenomenon? We are inclined to assign this peculiarity to the scrap trolley wire used in the mixture, as we always have had more or less trouble when using this class of material in making the alloy. We cut the copper into 3 or 4-inch lengths. A No. 70 crucible is charged half full of this scrap copper and after adding a piece of hardwood, the crucible is filled, another piece of hardwood being placed on top of the charge. When the copper is melted sufficiently hot, the lead is added, after which the pot is pulled, skimmed and the addition of tin is made. After the tin has been thoroughly incorporated, a piece of yellow phosphorus, about 2½ inches long is thrown into the metal and well stirred.

Trolley wire is a good material for these castings, but the difficulty is in melting it properly. The fact that the metal is clean after being skimmed is no indication that it is not full of oxides which will produce spongy castings. The point to be observed is whether the metal is mushy on top before being skimmed, for if it is, it is useless to pour it into castings, as they inevitably will be porous. In charging a No. 70 pot with cut trolley wire it is impossible to make the complete charge at one time unless a crucible ring is used, and in making the additions of wire after the first lot has melted, the danger arises from oxidation and gas absorption. It should be borne in mind that a submerged piece of charcoal is capable of causing as much trouble as a handful of copper oxide. Therefore, the charcoal should be kept on top of the metal and the piece of hardwood in the center of the charge should be omitted. Furthermore, do not throw the extra copper on top of the charcoal in such a manner that it will be pressed below the surface of the molten metal and held there. If you cannot arrange to make the complete charge of copper when cold, heat the first charge, and in making additions add only a sufficient amount to dissolve in the bath, then close the furnace and allow the metal to become hot. Then add more copper, proceeding as before and continue this until the entire charge is melted. This will require a little more work, but will insure sound castings. The phosphorus should be added to the copper before the lead and tin, and while the pot is still in the furnace. It is advisable, however, to use phosphor-copper in place of phosphorus to be certain that the phosphorus will enter the metal and accomplish its work as a deoxidizer. Use 2 pounds of phosphor-copper in place of an equal amount of trolley wire and add it after the copper is melted; then add the tin and the lead and stir the mixture well, remove the pot from the furnace and pour.

Lake Superior and Electrolytic Copper

What is the difference between Lake Superior and electrolytic copper and which grade is best adapted for use in bronze pump runners?

There is practically no difference between the best grades of lake and electrolytic copper, as both have the same high electrical conductivity, which is an index of the purity of this metal. For castings in which high electrical conductivity is important, electrolytic copper is the most dependable. Some brands of lake copper contain arsenic and for that reason are comparatively low in conductivity. However, for the same reason these brands of copper are preferred for making certain classes of castings and rolled material. For making bronze pump runners in which soundness is of more importance than the purity of the copper used, an arsenical brand of lake copper is preferred, as the arsenic, while not necessarily being a deoxidizing agent, prevents gas absorption by the copper. This metal in a molten condition has a great affinity for gases other than oxygen, which are retained when the metal solidifies and thereby produce porous castings.

What is Phosphor-Bronze?

What is phosphor bronze? Does the tin content of the alloy determine the name? Is an alloy containing 84 per cent copper, 5 per cent tin, 10 per cent lead, and 1 per cent phosphorus, equally entitled to the appellation phosphor bronze with an alloy of copper 80 per cent, tin 10 per cent and lead 10 per cent phosphorized, or does an alloy containing less than 8 per cent tin cease to be a phosphor bronze even though, as in the case of the alloy first cited, it contains a large percentage of phosphorus?

Phosphorous bronze is an alloy distinguished from all others by its phosphorus content, therefore it follows that any alloy containing phosphorus may be called phosphor bronze without a great stretch of imagination.

Nevertheless there are safeguards against imposition, for, strictly speaking, the term bronze applies to alloys of copper and tin only, and phosphor bronze, therefore, would more properly mean an alloy of copper, tin and phosphorus, such, for instance, as the following: Copper, 90 per cent; tin, 5 per cent and phosphor tin, 5 per cent. This alloy has a high tensile strength and cannot be duplicated in physical properties by any ordinary mixture, so that it is the only alloy that can be employed to fill specifications demanding the highest grade of material. In the case of bearing alloys such a safeguard does not exist, but large consumers can be relied upon to check their specifications by analysis. In this country, phosphor bronzes for bearing purposes are expected to contain lead, such as the 80-10-10 plus a specified amount of phosphorus, generally 0.30 per cent, or the well-known bearing alloy containing copper, 83 per cent; tin, 7 per cent; lead, 9 per cent, and phosphorus, 0.15 per cent. Highly leaded bearing alloys do not contain phosphorus, and therefore are not phosphor bronzes, for the reason that the addition of phosphorus would make it impossible to hold the lead in the mixture. The reason why phosphorus and high lead, say 30 per cent of the latter metal, will not remain together in the same alloy is due to the fact that lead does not alloy with copper, but is merely held in

suspension in the copper, existing in a state very much like water in a sponge, and anything that tends to close the grain of the metal, making it more dense, squeezes the sponge and throws out the lead.

An eminent English authority on phosphor bronze proposes the following specifications for a phosphor bronze alloy that shall possess a tensile strength of not less than 38,000 pounds per square inch with an elongation in 2 inches of 20 per cent. The alloy follows: Copper, 90 to 92 per cent; tin, 7.4 to 9.7 per cent. and phosphorus, 0.3 to 0.6 per cent. Out of 16 tests made, only one failed to run over 39,000 pounds tensile with 20 per cent elongation. For bearings the alloys in the accompanying table are given:

Copper, per cent.	Tin, per cent.	Lead, per cent.	Phosphorus, per cent.	Tensile strength per square inch, pounds.	Elongation, per cent in 2 inches.
89.7	9.4	nil	0.78	44,800	12
89.2	9.6	nil	0.71	44,800	15
89.0	10.1	nil	0.58	59,136	27
89.2	9.9	nil	0.54	38,700	..
89.9	9.5	nil	0.33	48,800	21
89.0	10.0	nil	0.50	33,040	..
89.8	9.3	0.27	0.49	39,200	22
89.2	10.6	nil	0.42	40,320	10.4
89.5	10.3	nil	0.32	40,320	12.5
89.4	10.0	nil	0.57	39,800	..

It is interesting to note that only one of the alloys contains lead and this in a very small quantity, a little over 0.25 per cent, and the addition of this amount of lead did not decrease the strength of the alloy to any marked extent; also, the elongation was higher than that of any other alloy in the series. In view of this it is apparent that there is a sound reason for the addition of small percentages of lead to English gear bronzes, which generally are phosphor bronzes.

While it is true that in all of the alloys cited the percentage of tin is over 8 per cent, other bronzes are employed in which this is not the case; thus for phosphor bronze wire the following alloy is used: Copper, 92.85 per cent; tin, 6.5 per cent, and phosphorus, 0.314 per cent.

As long as the name phosphorus is applied to this class of alloy to distinguish them from others not containing this element, it is evident that it will be difficult to draw the line as to what shall and what shall not constitute a phosphor bronze, as any alloy containing phosphorus is entitled to the appellation, even though it is merely a phosphorized yellow brass. Consequently, some fearful mixtures are made and are called phosphor bronze.

Low Shrinkage Mixture

We would like to have a formula for a metal pattern mixture that will show little or no shrinkage.

The following alloy will probably be found satisfactory: Zinc, 50 per cent, and tin, 50 per cent.

Bronze Cannon

Please give us a formula or a composition of metals suitable for bronze cannon. This formula will have to be submitted to experts before it can be used.

An alloy consisting of copper, 88 per cent; tin, 10 per cent and zinc, 2 per cent generally is used for making ordnance. This alloy is known as gun metal and occasionally is modified to decrease the tin content to 9 per cent and increasing the copper 1 per cent. The physical properties of the alloy will vary between wide limits, according to the degree of skill with which it is made. Properly melted and deoxidized the tensile strength of this alloy will be from 40,000 to 44,000 pounds per square inch and it will produce sound castings in sand. Another excellent alloy follows: Copper, 90 per cent; tin, 5 per cent, and 5 per cent phosphor tin.

An alloy undoubtedly superior to either of the above is the 10 per cent aluminum bronze, but to manufacture clean castings from this alloy requires great skill and the process of making sound castings free from blowholes, gas inclusions and oxide is a secret. Therefore, it is not advisable to attempt to cast this bronze and the two alloys first given represent the best that can be done in ordinary practice.

Deoxidizing Acid-Resisting Bronze

We are experiencing considerable difficulty in the production of acid-resisting bronze castings made from the following alloy: Copper, 85 per cent; tin, 10 per cent and lead 5 per cent. This difficulty is experienced whether the castings are large or small. The metal rises out of the pouring sprue, forming a mushroom head. We have experienced no trouble of this kind except when a high percentage of tin or lead is used. We operate natural draft furnaces, use 72-hour Connellsville coke and employ charcoal as the covering for the metal. No. 4 Albany sand is used for molding heavy work and No. 2 on bench work.

Your difficulty is due to the fact that no deoxidizer is being added to the alloy, as neither lead nor tin is sufficiently active in this respect to insure sound castings unless the melting is carried on with the greatest skill. The addition of 2 per cent of phosphor-copper in place of the same amount of copper in the charge will remedy the difficulty. Alloys of copper high in tin are subject to liquation. A compound rich in tin (Cu_4Sn) separates out after the alloy has solidified and forces its way out of the risers and sprues just before the latter harden, in some cases leaving cavities. The alloy given, however, should not be liable to this liquation and, therefore, the mushrooming of the sprues cannot be attributed to this cause and must be due to oxidation.

Difficulties in Making Bushings

We are experiencing some trouble in making large bushings in loam, which are from 150 to 300 pounds in weight. The metal washes off some of the loam from the sides and bottom of the mold. Can you suggest a good loam mixture that will give us satisfactory results, and if not, how would you suggest we proceed with the production of these castings?

It is not necessary to use loam for a 300-pound bronze casting, as it can be made in green sand provided a coarse open sand is employed. The mold also should be well slicked with a good grade of plumbago. We would suggest that you try a dry sand mixture as follows: Molding sand, 4 parts; lake sand, 1 part; flour, 1 part to 20 parts of sand; wet with clay wash. Paint the mold surfaces with plumbago wash and skin dry throughly. Pour while the mold is warm. The loam mixture used cuts because it is too close, or the mold is not thoroughly dry.

Polishing Iron Castings

We are manufacturing an article which includes an iron casting of irregular shape. We now pay two cents each for the castings and the cost of polishing the casting is four cents. We figure we are losing money. We want a satisfactory finish at a lower cost. Will you kindly inform us of practical methods for this purpose?

We have no doubt but that you can obtain equally as good or a better finish by tumbling in sand and burnishing with steel balls. This is being done every day. Use a horizontal iron barrel. One with conical shaped ends is the best. Fill the barrel about two-thirds full of castings, then add about a peck of crushed granite and moisten the whole with at least one quart of coal oil. These quantities suffice for a barrel 3 feet long and 20 inches in diameter. Treat in this barrel from 10 to 20 hours at about 40 revolutions per minute. Remove the castings and wash to free them from grit and dirt. Then transfer them to a clean, wood.

horizontal barrel, charged with small steel balls or flat steel punchings of circular form and a solution of soda ash, 4 ounces to a gallon of water. Five to 10 hours in this barrel at 40 revolutions per minute should produce a satisfactory finish on the castings at one-fourth the cost of polishing. Keep the wooden barrel free from sand or grit and use an abundance of balls or punchings.

Elimination of Dross

Our red brass for pattern work contains considerable dross and we would like to know how this can be eliminated. The mixtures we are using follow:

Copper, 81 per cent; tin, 4 per cent; zinc, 9.6 per cent, and lead, 6.9 per cent.

Copper, 85 per cent; tin, 3 per cent; zinc, 4 per cent, and lead, 8 per cent.

Dross in copper alloys is generally the result of poor melting practice. The copper should first be melted under a cover of charcoal and when ready for the mixture should be perfectly clear under the charcoal, a condition which is readily seen when the charcoal is pushed aside. If the copper has been kept covered while melting and clean metal has been used for the charge, no difficulty will be experienced in getting a good melt of copper. The mixtures then are added, the alloy is well stirred to insure thorough incorporation of the white metals, and if the metal is sufficiently hot to run the castings, the pot should be pulled immediately, skimmed and poured. If old scrap wire is used for the charge, or if charcoal is omitted, the molten copper may be mushy on top and such metal will produce drossy and porous castings.

The following mixture would be more satisfactory than either of the two mentioned: Copper, 85 per cent; tin, 5 per cent; zinc, 3 per cent, and lead, 6 per cent.

Tobin Bronze

Would be pleased to receive a formula for Tobin bronze and suggestions for the best method of melting and casting this metal. Also kindly let us know whether Tobin bronze is patented.

Tobin bronze is simply a high-zinc yellow brass, somewhat difficult to cast on account of its lack of aluminum. The following formula is frequently used: Copper, 58 per cent; zinc, 40 per cent; tin, 1.5 per cent, and iron, 0.5 per cent. Melt the copper and add the iron in the form of thin shavings of tin plate or galvanized steel, stir with a graphite stirrer and when the iron is dissolved add the zinc and lastly the tin. The addition of aluminum or silicon greatly improves the casting qualities of the alloy, but changes its appearance so that it resembles manganese bronze and if such appearance is objected to, the molds for heavy sections will require drying before being cast. This alloy is not patented.

Yellow Color on Babbitt Metal

Can you advise me what to add to babbitt metal to give it a yellow color? Will manganese do this?

The yellow color on the surface of babbitt metal ingots is produced by pouring them hot. The tin oxidizes and gives a pleasing yellow color to the ingot. Babbitt so colored usually is of high grade because the color is due to the oxidation of the tin. Lead anti-friction alloys cannot be so colored, but alloys containing 25 per cent lead and the balance tin, copper and antimony will color well. Manganese will assist materially in obtaining a good color, but the content of manganese has to be extremely low, as otherwise it will cause excessive drossing and loss of tin. The manganese should be added in the form of manganese-copper to the copper-antimony hardening when it is melted in the crucible and should not exceed one ounce of manganese-copper per 100 pounds of babbitt.

Iron also may be used to assist in coloring babbitt ingots. The iron should be added to the molten copper either in the form of tin plate or as yellow prussiate of potash. The maximum amount of iron is approximately 0.25 per cent. The yellow color does not extend into the babbitt metal, but merely is superficial. There is no possible way of making yellow babbitt metal, because all soft metals are white, brass being the only yellow metal in commercial use.

Victor Vanadium Metal

Can you give us the mixture of Victor vanadium metal?

Victor metal is a cheap German silver. Its composition follows: Copper, 50 per cent; nickel, 15 per cent, and zinc, 35 per cent. To improve its casting qualities, 2 ounces of aluminum per 100 pounds usually are added.

A Strong Aluminum Alloy

Kindly give us a mixture for a strong aluminum alloy for making rings or links which will sustain considerable weight.

The following formulas will give you a wide selection of alloys suitable for your purpose:

Aluminum, 94 per cent and copper, 6 per cent.

Aluminum, 82 per cent; zinc, 15 per cent and copper, 3 per cent.

Aluminum, 93 per cent and magnesium, 7 per cent.

Aluminum, 68.25 per cent; zinc, 30 per cent and copper, 1.75 per cent.

Effect of Repeated Remelting on Copper

By F O Clements

THE ultimate aim of the nonferrous metal founder is a high grade product and a diminished scrap pile. Many considerations enter into the production of sound castings. In addition to the melting temperature, the degree of fluidity of the melted metal itself, at a given temperature, exerts probably the most decided influence upon the successful outcome of a difficult job. Alloys made in regular practice, are frequently over-heated, and in some cases burnt. This is done usually from a desire to increase fluidity.

The customary statement made by foundrymen that repeated remelting of metal, very decidedly injures the casting properties, would be granted, without question, by every practical foundryman. It seemed advisable, however, to devise a series of tests which would quantitatively measure the soundness of castings, and thereby give some comparison as to the relative amount of oxygen and other impurities absorbed during the melting process.

In considering the various type of physical testing apparatus, the fiber stress or endurance machine developed by Messrs. Upton & Lewis, of Cornell university, seemed to most accurately predict the casting conditions. At least the fiber strength revealed on the Upton-Lewis machine has very close correlation to the casting properties. Oxidation makes sluggish metal and consequent poor fiber — sluggish metal will not properly fill the mold — an effort still further mechanically affecting the strength of the product. This particular machine produces alternate bends on quickly made test specimens 1 inch wide and of any given thickness, making

Portions of a paper presented at the annual meeting of the American Institute of Metals, Chicago, Sept. 7-11, 1914. The author is connected with the National Cash Register Co., Dayton, O.

graphic record of the number of bends and the resistance the part offers to the load prior to fracture.

This machine, as originally designed, offered resistance through spring action. This has been modified in the National Cash Register Co.'s laboratories, so that pendulum resistance has been substituted for the springs, permitting loading somewhat in accordance with the sectional area of the test bar itself.

After the completion of the physical tests on the virgin copper as purchased, 100 pounds of the metal was melted under exact foundry conditions and brought to a satisfactory casting temperature. This temperature proved to be, in heat No. 1, 1120 degrees Cent. Regular foundry practice was followed in every particular, the metal being kept well covered with charcoal to prevent undue oxidation. This metal was cast into good appearing ingots, which proved very solid throughout. Four samples were machined from a random ingot and tested for toughness of fiber. The metal, at the same time, was analyzed. The metal was then all reassembled and again remelted at the same temperature as reported heretofore. The second heat resulted in solid ingots, a slight bulge appearing on the top of each.

The third heat seemed sluggish and the temperature of the metal was raised to 1165 degrees Cent. The ingots had a bad exterior, containing blow holes to the depth of one inch. The metal was very spongy and unreliable.

In the fourth heat, the metal recovered from the various operations was again remelted and cast at a temperature of 1115 degrees Cent. The ingots were very spongy and full of blow holes; in fact, the metal was so unreliable that it was almost impossible to machine test bars that gave any indication whatsoever of good features. The breaks showed discolorations and badly oxidized spots.

The data obtained from the chemical and physical tests is to be found in the accompanying table.

The question naturally arises, can a metal in such injured condition be deoxidized and restored to its former condition? Every foundryman recognizes the advantages derived from fluxes. The use of fluxes or the benefits to be obtained therefrom to our knowledge have never been quantitatively determined.

The last two sets of figures included in the table shows very conclusively the value of boron suboxide as a flux. Following the directions of the General Electric Co., two ounces of boron suboxide were added to 16 pounds of the badly injured metal. The copper was heated to 1260 degrees Cent., in order to secure the best results from this particular flux. The metal was then allowed to cool down to a casting temperature of 1149 degrees Cent., and again cast into ingot form. The ingots had a good appearance, were solid, and the fiber seemed remarkably close, as is evidenced by the results obtained on the endurance machine. The diagrams produced were slightly irregular, but considerably longer than all others, including the virgin copper.

FIG. 1—CYLINDER MOLDS SHOWING THE POURING BASIN AND METHOD OF HOLDING THE CORE

EFFECT OF REMELTING ON COPPER

Physical Data.

	Virgin metal.	First heat.	Second heat.	Third heat.	Fourth heat.	Boron suboxide.	Sample of Boronized copper cast under ideal conditions.
Average No. alternate bends	1,515	850	845	762	334	2,007	3,044
Resistance offered in bending, assuming virgin metal at 100 per cent.....	100	97	96	96	96	103	117.5
Percentage of drop-off of resistance in 10-in. lengths	2.7	5.5	4.9	8.5	22.6	2.7	0.74

Chemical Data.

Copper, per cent.....	99.78	99.59	99.49	99.43	99.39	99.56
Lead, per cent.....	None	Trace	Trace	Trace	Trace	Trace
Sulphur, per cent.....	0.03	0.06	0.08	0.11	0.13	0.08

Molding Pistons

By D. O. Barrett

The method of making gas engine cylinders to be described was determined upon after several efforts were made to ascertain the most economical way of doing this work.

The mold is made on the bench, the pattern being provided with the usual tapered print at the open end from which the core is located and hung. The flasks are round and provide for a wall of about ½-inch sand outside the print. On each side of the flask at the top is cast an ear with the lower edge tapering. The cross bar at the top is provided with hooks corresponding to this taper and when in place and slightly turned it exerts a pressure on the core in the center only, a boss being provided for this purpose. A small, dry sand core, which serves as a pouring basin, is pasted to the core at one side, the print and core having been cut away for this purpose. The flasks shown in Fig. 1 at first were set on wooden bottom boards, but latterly round cast iron plates were made and now are being used. No weights are necessary when this method is followed, which has proved entirely satisfactory and this method of molding pistons is more rapid than when making them in multiple on the floor. Fig. 2 is a cross-section of the mold showing the pouring basin and the method of holding the core.

T. A. Willson & Co., Inc., Reading, Pa., manufacturers of eye protectors and goggles, were awarded the grand prize at the Second International Exposition of Safety and Sanitation recently held at the Grand Central Palace, New York City.

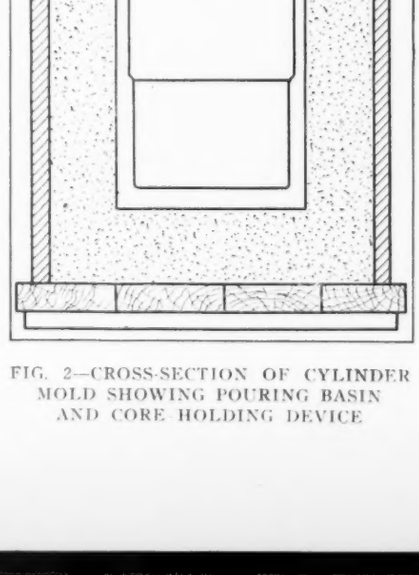


FIG. 2—CROSS-SECTION OF CYLINDER MOLD SHOWING POURING BASIN AND CORE HOLDING DEVICE

A Light and Practical First Aid Jar for Shops

A Jar Designed by Magnus W. Alexander Which Contains All Necessary Medicaments, Bandages, Splints, etc., to Render First Aid

FOUNDRYMEN who attended the 1914 convention of the American Foundrymen's Association in Chicago, or that of the National Founders' Association in New York, doubtless retain a vivid recollection of the new N. A. S. O. first aid jar, which was exhibited and described on both occasions by M. W. Alexander, West Lynn, Mass. In order further to spread among employers information in regard to this remarkable outfit, the National Founders' Association has issued an illustrated bulletin describing it. This bulletin gives details regarding the proper materials for use in first aid treatment, and follows naturally the association's bulletin No. 17, which contained a treatise on the proper methods of giving first aid treatment to injured and sick persons.

Every feature connected with the new first aid jar serves to emphasize the painstaking care which attended its preparation. The jar contains apparatus and medicaments required for the effective treatment of slight wounds, or for emergency treatment of serious injuries. The materials which it contains were picked out by a conference of physicians, all of whom possessed extensive experience in the treatment of injuries. The jar is constructed of glass, which material was selected for numerous reasons. Due to its transparency, the contents of the jar can be seen at a glance, thus making it unnecessary to disarrange the entire jar in order to get at an article which may be at the bottom. Secondly, the use of glass permits of more sanitary conditions than if the jar were of wood, tin plate or some other material.

FIG. 1 — THE JAR WEIGHS ONLY 12 POUNDS AND MAY BE CARRIED EASILY

The jar is structurally strong and is made stronger by a special annealing treatment. It also is comparatively light, the weight of the entire outfit being only slightly in excess of 12 pounds. It is provided with smooth walls to promote cleanliness and to facilitate the removal of the first aid materials. The jar is contained in a wire cage which is provided with spring clips for clamping the cover in place; the cover also is of glass and in it is molded a handle for carrying. A rubber gasket between the jar and the cover makes the outfit dust and waterproof, and equalizes strains in the cover. The jar is made only high enough so that the cover, when set in place, rests on the stoppers and prevents them from coming out of the bottles.

The jar is 9½ inches in diameter, and 6 inches high. The quantity of material which is carried in this small space is surprisingly large. The contents of the jar are as follows:

One tourniquet.
One pair nickel-plated scissors.
One pair nickel-plated tweezers.
One triangular sling.
One wire gauze splint.
Twelve assorted safety pins.
One 2-ounce bottle Castor oil.
One 2-ounce bottle 3 per cent alcoholic iodine.
Two 3-ounce tubes burn ointment.
One 2-ounce bottle white wine vinegar.
One 2-ounce bottle 4 per cent aqueous boric acid.
One 2-ounce bottle aromatic spirit of ammonia.
One 2-ounce bottle Jamaica ginger (or substitute).
One piece of flannel, 24 x 36 inches.
One roll absorbent cotton (1.5 ounces).
One roll 3-inch x 10-yard gauze bandage.
One roll 2-inch x 10-yard gauze bandage.
Two rolls 1-inch x 10-yard gauze bandage.
One spool 1-inch x 5-yard adhesive plaster.
Six packages 6 x 36-inch sterile gauze.
One teaspoon.
One metal cup.

FIG. 2—N. A. S. O. STANDARD FIRST AID JAR AND CONTENTS

FIG. 3—THE ARRANGEMENT ALLOWS THE QUICK REMOVAL OF ANY ARTICLE WITHOUT DISTURBING THE OTHERS

FIG. 4 — FOR TRANSPORTATION THE JAR IS PACKED IN A WOODEN BOX

One medicine glass.
Two medicine droppers.
Three paper drinking cups.
First aid record cards.

One of the most interesting items on this list is the splint. This is a 4½-inch strip of flexible wire gauze, 30 inches long, wound into a small roll; it can be cut as required and shaped around the broken limb. This splint provides effective temporary protection to the limb until a physician can set the fracture.

Although the use of water in first aid work is not contemplated, both the jar itself and the metal dish which it contains can be used as water vessels when necessary. Complete directions as to the use of the contents are given on a circular pasted on the inside of the glass cover. The jars are shipped in padded wooden boxes. Their selling price is $5.50 each and they may be ordered from the secretary of the National Founders' Association, 29 South La Salle street, Chicago.

Where Are the Profits in the Foundry Business?

By A G Dean

WHERE are the profits in the foundry business? This is a very sensible question to ask at any time, and particularly when foundry production is at low ebb in the tide. My answer is an indirect one. The profits in the foundry business depend on co-operation in its broadest sense, co-operation among local foundries; co-operation with your customers; with your banks; with your employes, and with your supply dealers. Now I do not mean the kind of co-operation, that is, all give and no take. I mean cold, hard business sense co-operation for profit.

The banks are in business for profit. You are dependent upon the support of your bank, your stockholders and the men who extend credit for materials. They are very glad to give you their support on the condition that you offer a safe investment. You must co-operate with them and show them a properly conducted business. This includes a knowledge of costs; a well organized foundry and sales department, whereby you produce and sell at a profit. It is essential to have a good reputation for the work you turn out in all departments.

Your location, equipment and knowledge of the foundry business must show that you can compete and secure business at a profit. When you can fill these requirements, you can command financial support.

Many foundries are operating without a true knowledge of their costs. In many cases the buyer practically dictates the price he pays for castings. This is a fact. Recently a manufacturer asked for bids on 100 castings of an engine base made with a core. The weight was 175 pounds each. Two bids were asked. One was $2.90 per hundred pounds, the other $2.50. The buyer figured six to eight bases a day for a molder, a helper and a core maker, and offered $2.40 a hundred pounds. The offer was accepted. One bid was 20 per cent higher than this price and the low bidder accepted a reduction of 4 per cent, because the buyer figured the cost of production for him.

The customers of a foundry should co-operate with the foundry for their own benefit and protection; otherwise the percentage of loss in machining bad castings runs high. A customer should have a competent man visit the foundry at least once or twice a week. Patterns should be made the simplest and easiest way for the molder. They should be kept in first class condition.

All patterns should be numbered so that the castings will show a number. This will save time and expense. A list of patterns should be given to the foundry. This list will show the management if the patterns are numbered and properly checked. It should give the pattern number, name, weight of casting and details for reference and checking. I have used such a list also for invoicing; thus saving re-writing and errors. Columns are left for corrected weight, number of pieces, prices, etc.

Customers should co-operate in every

An address given before the Philadelphia Foundrymen's Association.

way possible to save time and money for the foundries. Stock orders and all orders in writing with duplicate copies for office and foundry are of great assistance. The foundries can easily standardize order forms in this way. This would save time and considerable expense in re-writing orders. Watch shipments and returns. Good castings mean profits and are also worth more money.

A recent paper by Stewart Dean of Indianapolis gives an excellent idea of foundry organization. Note the co-operation, which is essential. He suggests the following:

Select capable men as foremen and bosses.

Give each molder 30 minutes attention from his boss each day.

See that materials are ready to work with and are in good condition.

Then push for the tonnage.

Create competition among the foremen and encourage them to bid on jobs.

Use department reports.

Develop a uniform cost system (with other foundries).

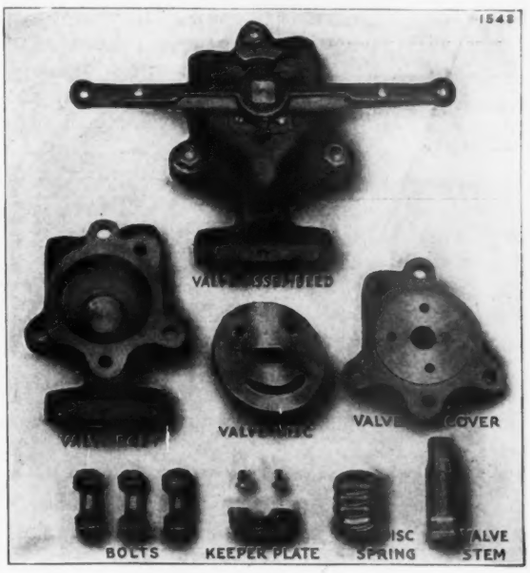
Base this system on pounds per man. Extend the costs for different departments and for total cost.

An elaborate cost system is out of place in a foundry. I have heard the cost clerks called shoe clerks, either because they understand so little about the foundry business or the name suggested the manager footing the bills.

Supply men are material experts and know what other foundries are doing. Secure their co-operation. They can be of great assistance to you, both in securing greater production and financially. They extend a material credit that corresponds to the bank's loan. Buying successfully is an art and the systems used by other foundries, together with your system, should save you considerable money to be used for improvements or dividends. A stock book arranged with loose leaf specification sheets will be found invaluable. Each item purchased has its specifications, prices, discounts and terms. The specifications will interest material salesmen and will save verbal inquiries and loss of time. The information secured from salesmen is often added to the specifications. A separate color sheet is inserted for quotations that are kept for reference.

Co-operate with your employes along modern lines to build up, as far as possible, a loyal lot of workers. Determine the qualities necessary for a successful molder, core maker, etc., covering all positions. Do this with the foremen's assistance. Give this information in writing to the man or men who hire the employes, and secure a record for every man hired. Go over these records occasionally with the different foremen and with the cost and production records before you. The effect will be greater care in hiring men and increased production. Instruct and interest your employes in efficiency. Pay well for good work. Push the work and increase the tonnage.

Co-operation among local foundries will take into consideration the large amount of castings bought outside. This will call for an investigation of competitive conditions. Many jobs go out of town because the buyer does not know the local foundries that specialize on his work, or the buyer has been talked into placing the work outside, even at a higher total cost, with freight and returns considered. No one foundry can afford to take up this investigating and educational work. The needs for a permanent paid secretary are numerous.



AIR HOIST VALVE

First—To get up a uniform cost system to educate the competitors who do not know their costs. Their competition demoralizes the foundry business and gives it a bad name with the banks and material men because of their failure. They establish unprofitable prices for work. Customers grow dissatisfied and change, frequently going out of town for castings. Changes from one foundry to another are expensive. Better local foundry conditions would justify the customers paying higher prices for better castings and service.

Second — An unorganized foundry creates labor troubles for the entire trade.

Third—Your permanent secretary can remedy many of these evils by showing these unfortunate competitors the right way to figure costs and how to add a profit above the combined cost of materials, labor, sales and overhead expense.

I have gone far enough to show you the importance of co-operation in producing profits. The several subjects treated should be further developed. Since you know where the mistakes and troubles are to be found in the foundry business, you can assist in eliminating them. In this way you help others while helping yourself. No man enjoys making a failure in the foundry business. Why not get together and co-operate for profits all around in the foundry business?

Air Hoist Valve

An air hoist valve of interesting design recently has been developed by the Whiting Foundry Equipment Co., Harvey, Ill. It is of the disc type and is designed to operate under severe service conditions. The valve consists of a brass disc operating in a cast iron body, the former being held in place by air pressure and also by a coil spring. The valve seat and disc are ground together to an air-tight fit. The valve lever moves through an arc of 45 degrees from the central position. The valve is so designed that the stem does not pass through the air chamber, thus eliminating leakage at this point. No packing is used and the valve cover and disc may be removed without disconnecting the pipe.

Death of Major Brewster

Major Henry M. Brewster, formerly head of the Stebbins Mfg. Co., Springfield, Mass., died at his home in Springfield, Jan. 10, after a short illness, at the age of 73. Major Brewster for many years had been prominent in eastern foundry circles and was particularly well known for his work in developing and marketing the original Millet core oven. He became connected with the Stebbins Mfg. Co., in 1878, holding different positions until finally he was in control of the business at his retirement in 1907. At the time of his death he was connected with the Equitable Life Insurance Co.

A 20-page booklet entitled "Synopsis of McLain's System" has been issued by this school, which is located in the Goldsmith building, Milwaukee. The system is briefly described and a synopsis is given of each of the 12 correspondence lessons.

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Trade Outlook

ALTHOUGH undoubtedly several months must elapse before the foundry industry will again be on a normal basis, evidences that improvement has set in continue to multiply. Melters in the east have expressed their confidence in the situation by making fairly liberal purchases of pig iron. There has been some improvement in railroad equipment orders which has affected the operating schedules of the western malleable shops. The latter have been running on a very low basis for some months but during the last two weeks in January there were fairly heavy sales of malleable pig in the Chicago district. It is estimated that there has been an increase in the production of castings since the middle of December amounting to about 15 per cent. A large proportion of the business enjoyed at the present time is the result of heavy orders for machine tools, automobiles, motor trucks, artillery, shrapnel shells and other munitions of war received from the belligerent countries of Europe. In purely domestic lines we find that agricultural implement shops and some railroad foundries are increasing their melt. The financial stringency which placed such a powerful brake on industrial progress during the fall months has been entirely relieved. Money at present is abundant; interest rates are low and bankers have reached the point where they are seeking good loans. Bargains are still available in pig iron and prices remain practically unchanged. No. 2 foundry is quoted $13, Chicago; $12.75, Ironton; $13, Cleveland; $9.50, Birmingham and $13.70, Pittsburgh. Malleable may be obtained for delivery up to Apr. 1 at $13, Chicago; $14.75, Philadelphia; $13.70, Pittsburgh and $13, Buffalo. Lake Superior charcoal may be had at $15.75, Chicago or Buffalo; 8 per cent silveries are quoted $16 f. o. b. Jackson furnace; low phosphorus is quoted $20.95, Pittsburgh.

Paying for Pig Iron

A new method of financing pig iron purchases is advocated by Isaac F. Marcosson in an article in the Jan. 7 issue of *The Iron Trade Review*. He proposes that pig iron producers and consumers take advantage of the new currency law providing for the discount of acceptances by the Federal Reserve banks. A foundryman buying say 500 tons a month would "accept", that is agree to honor, 90 day drafts for the shipments. The drafts would be discounted by the seller and collected by the bank when due. The purchaser, thus, would get three months' time on his bills and the seller would get his money within a few days from date of shipment, the bank carrying the loan. Under ordinary circumstances the foundryman would not have to pay for the iron until he had been paid for the finished castings into which it had been converted.

Pipe Production

According to statistics compiled by the American Iron and Steel Institute the production of cast iron gas and water and soil and plumbers' pipe and fittings amounted to 1,266,245 net tons in 1913, of which 1,200,289 tons were gas and water pipe and fittings and 263,956 tons were soil and plumbers' pipe and fittings. The production of gas and water pipe includes 46,831 tons of fittings, while the production of soil and plumbers' pipe includes 68,925 tons of fittings and 7,727 tons of culvert pipe. Sixty-seven plants were actively engaged in the casting of pipe, Alabama leading with a total of 15 foundries.

A Crane Sand Cutting and Tempering Machine

Description of an Interesting Device for Tempering and Cutting Over Sand in Steel and Heavy Gray Iron Foundries

GREAT steps forward have been made in the past few years in adopting mechanical devices for tempering and cutting sand in all classes of foundries. In steel foundries, however, as well as in certain malleable and heavy machine and jobbing foundries, somewhat less progress has been made because until recently no machine was available for the particular class of work which these foundries handle. In foundries of this type it is not customary to cut over the sand in long windrows but in heaps of various sizes distributed about the floor. These conditions do not lend themselves to the employment of what is known as the auto, or floor propelled type of sand mixing machines. Recently, however, the Sand Mixing Machine Co., New York, has developed a new machine which may be suspended from a traveling crane and thus "spotted" at any point on the floor where there is a heap of sand to be cut. The characteristics of this machine are shown in Figs. 1 and 2.

The crane machine is similar to the standard type built by the Sand Mixing Machine Co., except that it is provided with small wheels and is shifted entirely by the crane. It is suspended from the crane hook by four heavy chains secured to eye bolts in the four corners of the machine. Two of the chains are provided with turnbuckles for purposes of adjustment.

The frame of the machine is steel and the cutting cylinder is housed with steel plates. The blades in the cutting cylinder are so shaped that each one cuts off a small quantity of sand and throws it high in the air behind the machine, breaking all the lumps and separating the grains. It is said that each grain is thoroughly aerated. The sand is cooled rapidly and the steam and gas has every facility to escape. The heap, also, is left loose and light from top to bottom. The cutting cylinder revolves in Hyatt roller bearings which are dust proofed with a leather washer and three hard grease rings. It is said that the bearings need to be lubricated but once a year. On the crane type machine, the take-up reel for the electric cable is unnecessary, the current being led to the machine through a loose cable suspended from the crane.

Owing to the mobility of this type of machine, it can be used under conditions where the floor type would not be practical. This applies particularly to steel foundries where the sand is cut over in heaps, some of which may be 12 or 14 feet high. Foundries of this type usually are not provided with aisles in which the sand may be cut over. With the crane, however, the machine may be placed anywhere the sand heaps happen to lie. The size of the heap is said to be immaterial. The only condition necessary is bridge crane service above the sand and an intelligent craneman. It is stated that the burned sand which goes back into the heap is thoroughly distributed and that therefore a maximum quantity of this material may be used without harm, thus decreasing the consumption of new sand.

This type of machine also has been designed particularly for stationary machine molding where the sand must be cut and piled back of the machine

FIG. 1—CRANE TYPE SAND CUTTING MACHINE AT WORK

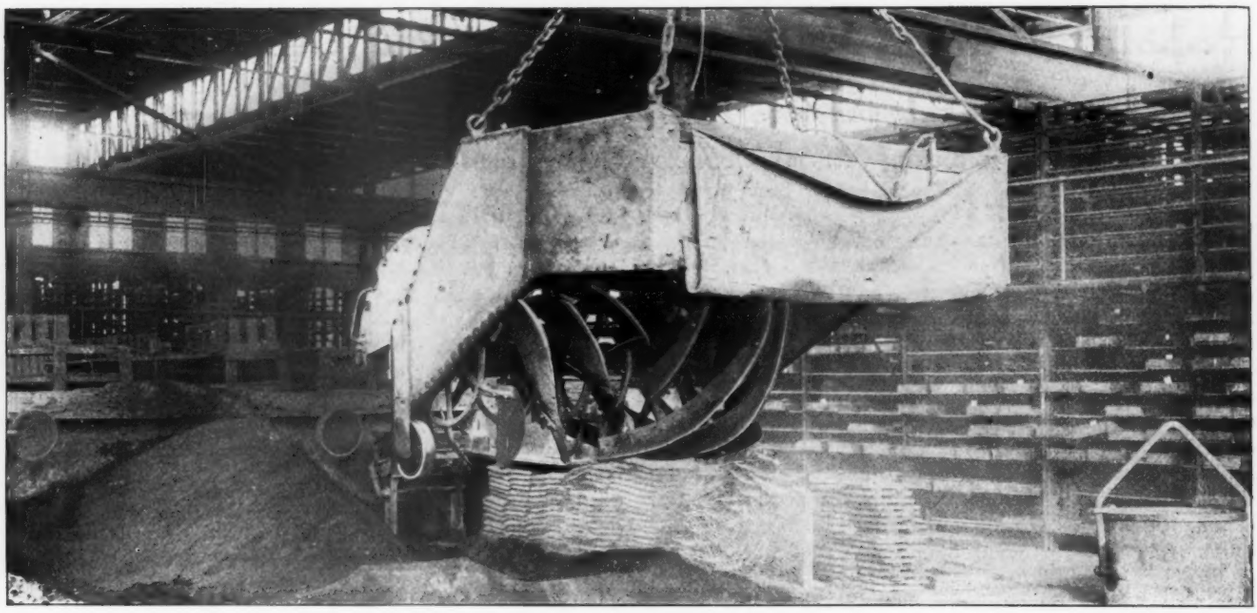

FIG. 2—MACHINE BEING SHIFTED BY CRANE

after it is shaken out and wet down. The machine is designed to pile the sand wherever it is wanted. This is illustrated by Figs. 3 and 4. Fig. 3 shows the sand heap ready to be cut but before the machine has gone through it. Fig. 4 shows the same heap after it has been cut and piled by the machine.

The best modern steel foundries find it a paying proposition to give particular attention to the condition of their sand and in many shops a large gang of men is employed every night to thoroughly prepare the sand for the next day's work. In shops where more than one heat is poured a day, a day gang of sand cutters is also necessary. The time apparently has gone by when the steel foundryman thought it unnecessary to give his sand any particular attention. As a matter of fact, unless the heap sand is in a thoroughly renovated and properly tempered condition, trouble will be experienced regardless of the type of facings which may be used.

Furthermore, the great difficulty in getting laborers to cut sand properly is well known. It should be remembered, however, that the laborer has nothing more to encourage him than a small daily wage. In this connection the following quotation from a paper on mechanical sand tempering, read by V. E. Minich before the American Foundrymen's Association, is interesting. "It is not surprising," said Mr. Minich, "that the laborer should sometimes become discouraged and spend a night over a can of beer, leaving an uncut sand heap to face the molder on his arrival on the job five minutes before the whistle. Under such circumstances, whether or not the molder cuts it himself and works that day, is likely to be determined by the urgency of little Jimmy's need for a pair of shoes, or perhaps it depends upon who 'rules the roost' at home. To avoid the loss from such occurrences, some foundrymen require their molders to cut their own sand regularly. This can only result in a waste of the molder's skill, energy and productive capacity and a direct and material reduction of profit, which could be avoided by the use of sand cutting machinery, if supported by efficient management and active supervision.

"While French, German and other foreign foundrymen seem long to have realized the value of perfectly cut sand, it is certain that the majority of our foundrymen have been somewhat slow to recognize or accept its importance. They have freely admitted that better cut sand produces better castings with smaller loss, but having made the admission, they have continued to permit the use of poorly

FIG. 3—SAND HEAP BEFORE CUTTING

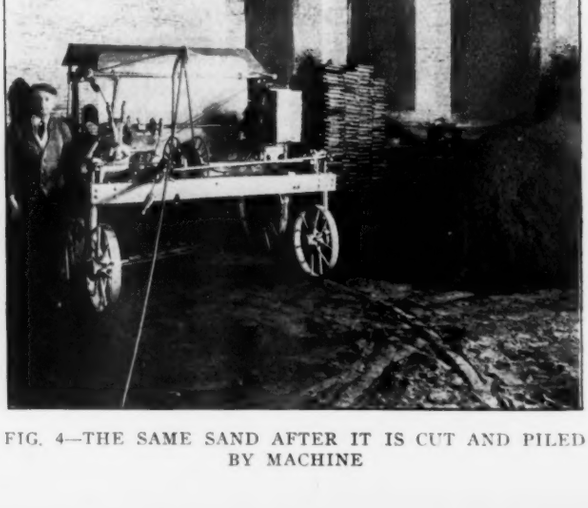

FIG. 4—THE SAME SAND AFTER IT IS CUT AND PILED BY MACHINE

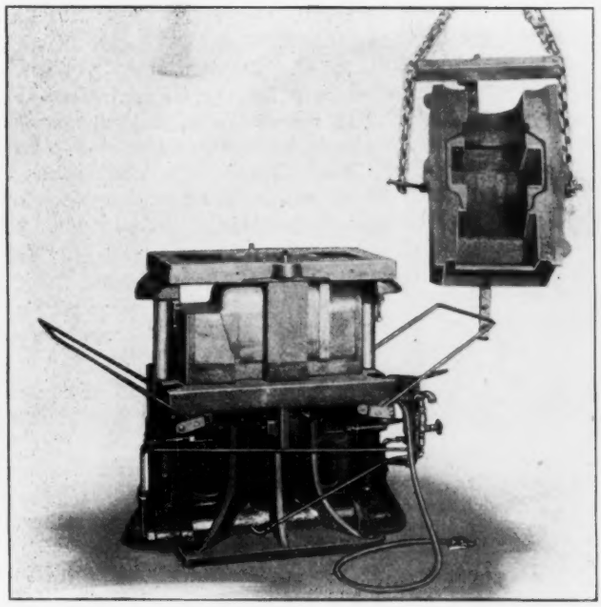

FIG. 1—OSBORN JOLT STRIPPING PLATE MACHINE WITH PATTERN AND MOLD

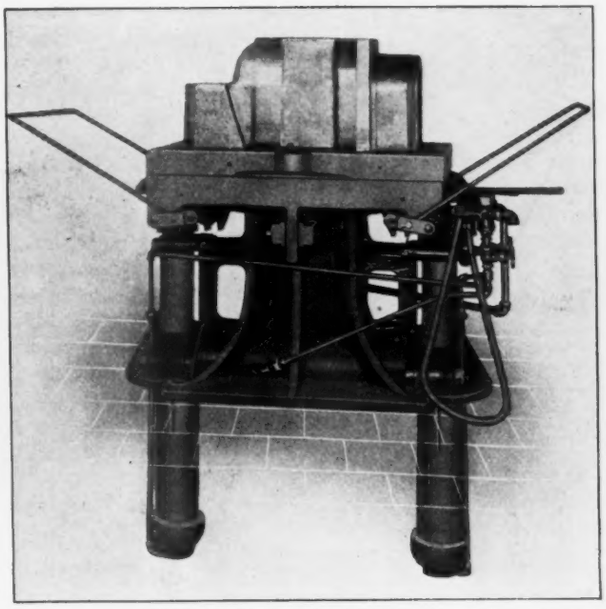

FIG. 2—END VIEW OF MACHINE SHOWING CYLINDERS EXTENDING BELOW FLOOR LINE

cut sand in their foundries, apparently losing sight of its bearing on their production and profits. But encouraging signs are not wanting. Each year discovers an increasingly large number of foundrymen who have caught the spirit of the times. They are wide awake and ready to test any improvement in shop practice, or any mechanical device, asking only that it shall offer fair promise of increasing production, improving quality and reducing loss, and that it shall save hand labor which is always at a premium when times are good."

New Osborn Molding Machine

A new stripping plate jolt machine which is specially designed to perform automatically practically all of the operations necessary for making a mold except shoveling the sand has been perfected by the Osborn Mfg. Co., Cleveland. The machine, it is said, is adapted especially for making molds for journal boxes and other comparatively heavy repetition work. It may be used with any of the standard types of stripping plate equipment. The pattern is drawn through the plate by power, and accuracy, therefore, is a feature upon which the builders lay considerable stress.

The machine has a rated stripping capacity with 80 pounds air pressure of 800 pounds, a maximum stripping capacity of 1,000 pounds and a maximum jolting capacity of 1,200 pounds. The table is 19⅜ inches wide and 32 inches long. The jolting cylinder is 6 inches in diameter and the draw cylinders are 3½ inches in diameter. The machine is arranged to draw patterns up to 1¾ inches in depth. The top of the table is 24 inches above the floor line. The size of the table can be varied and where the machine is intended for use with one particular pattern, it is advisable to have it approximately ⅛ inch less than the flask size. In such a case there is no opportunity for sand to accumulate on the table.

The jolting mechanism is of standard Osborn construction. The draw cylinders are cast in one piece and are connected to the base of the machine by large fitted bolts. As shown in the accompanying illustrations, these cylinders extend below the base. They are designed to set inside of 8-inch pipes inserted in the foundation. The piston rod, which also acts as a guide rod, is planed on one side and provided with gear teeth which mesh with pinions cut in a solid shaft extending from one cylinder to the other. The pinion shaft and guide rods are entirely enclosed and self-oiling.

The machine is provided with flask clamps operated by air. They are of the bail type, swinging over the end of the flask. The bail is made of spring steel in order to compensate for unevenness in the size of the flask.

After the flask has been filled and jolted, the air is turned into the draw cylinders, which rapidly strip the flask and stripping plate upward from the pattern. After the mold is lifted away, the valve handle is turned to the opposite position; this supplies air above the piston for returning the stripping plate to its original position.

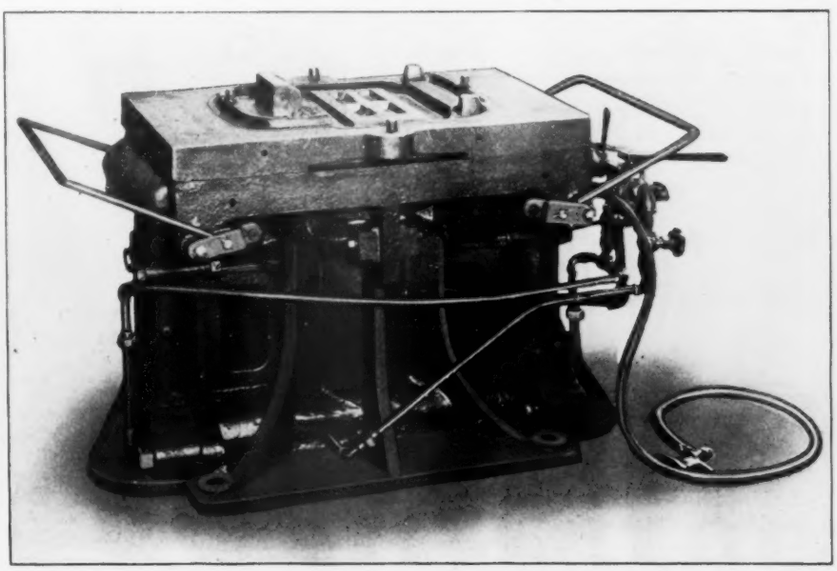

FIG. 3—JOLT STRIPPING PLATE MACHINE READY TO RECEIVE FLASK

FIG. 1—DETAILS OF ADJUSTABLE HAND LADLE SKIMMER

It is said that it is not necessary to wait while the exhaust escapes from underneath the cylinder and then depend upon gravity for the return of the plate. The air pressure admitted above the piston drives the plate back rapidly. The power return also furnishes sufficient force to overcome the resistance caused by sand wedging between the pattern and the stripping plate.

Adjustable Hand Ladle Skimmer

A hand ladle skimmer of a new type recently has been placed on the market by the J. W. Paxson Co., Philadelphia. The principal features of the device are shown in the accompanying illustrations. It consists of a frame which is clamped securely to the ladle shank, together with an adjustable skimming blade and a safety shield. The position of the blade may easily be controlled by the molder's thumb and the blade springs out of the way when released after pouring. It is said that one blade will skim from 500 to 1,000 molds. The blade may be easily changed, being held in place by a thumb screw. Either right or left hand blades may be used and for skimming copper, brass, or other alloys, the device is fitted with a graphite blade. It is said that when this skimmer is used, no dirt can enter the sprue while pouring, thus resulting in an average saving of 20 per cent on small work. The molder can operate the device unassisted while pouring. The skimmer is not in the way when ladle bowls are changed. The spring is covered and protected and is placed at a considerable distance from the bowl where it is not affected by heat or by splashed iron or dross. The device weighs about two pounds and is designed to fit any ladle shank. If the blades are washed over with blacking, claywash or loam it is said their life is indefinitely increased.

Personal

W. M. Hood has been appointed general manager of the Bellwood Mfg. Co., Bellwood, Pa.

C. C. Shaw, formerly associated with Hertzler & Zook, Belleville, Pa., has been placed in charge of the foundry operated by H. W. Gerlach, Huntingdon, Pa.

At the annual meeting of the stockholders of the Beaumont Iron Works Co., Beaumont, Texas, officers for the ensuing year were elected as follows: L. J. Black, president and manager; T. S. Reed Sr., vice president; B. R. Norvell, treasurer; Chas. B. Sheeks, secretary.

R. M. Nicholson, former advertising manager for the Kimberly-Clark Paper Co., Neenah, Wis., and who was previously employed as space buyer for the Cramer-Krasselt Co., Milwaukee, has been appointed advertising manager of the Berger Mfg. Co., Canton, O.

L. E. Marceau has resigned his position as foundry superintendent of the Dunham Co., Berea, O. For the present he will retain his residence at Berea.

Frank Curtis, formerly with the Best Mfg. Co., Pittsburgh, has taken an interest in the Hubbard Steel Foundry Co., East Chicago, Ind., and has been elected president and general manager.

W. L. Thompson, who during the past four years was in charge of the government steel foundry at Chagres, Panama canal, has been appointed superintendent of the foundry of the Page Woven Wire Fence Co., at Monessen, Pa.

E. B. Keating, formerly employed at the Monitor Drill plant of the Moline Plow Co., St. Louis Park, Minn., has been appointed assistant superintendent of this company's plant at Moline, Ill. J. A. Warner succeeds Mr. Keating as foreman of the St. Louis Park plant.

J. W. Payne, formerly manager of the San Francisco office of the American Optical Co., has been appointed Pacific Coast manager of T. A. Willson & Co., Inc., Reading, Pa., makers of eye protectors and goggles. The San Francisco office will be located in the Head building. The Willson company also announces that it can give excellent service abroad through S. Pulzer, 9 Hatton Garden, London, Eng., who carries a heavy stock of goggles in that country.

FIG. 2—ADJUSTABLE HAND LADLE SKIMMER IN OPERATION

Book Review

Practical Iron Founding, by Joseph G. Horner, A. M. I. Mech. Eng., fourth edition, revised and enlarged. Published by D. Van Nostrand Co. and furnished by THE FOUNDRY for $2 net.

Practically double the matter in the previous editions is contained in the fourth edition. Great changes in iron founding have taken place since the book was first written, more particularly in machine molding, and much attention has been paid to this subject in the new volume. British and American molding machines are described at length, their operations are analyzed, their application to various types of foundries are covered and their economies outlined.

The book is written and published in England and is of value to the American foundryman in showing how the work is done abroad. The matter strictly local to England is small. The chapter on loam molding is particularly complete, and goes into very full detail as to methods of forming molds in loam, a specialty in foundry work requiring a high degree of skill and judgment. An unusual number of illustrations, both drawings and halftone plates, renders the text the more valuable. The book is written for the student as well as for the practical man.

Thirty Years of Progress

A handsomely illustrated, 52-page brochure entitled "Thirty Years of Progress," has been issued by the Pawling & Harnischfeger Co., Milwaukee, in commemoration of the 30th anniversary of this company. The development of the business to its present large proportions is traced through the various stages and views are included showing the various small shops operated, with each succeeding one larger than the one preceding until the new plant was built and occupied in the spring of 1905. A large number of views of the works are included showing the various departments. Considerable space also is devoted to the personnel of the organization, portraits of the department heads and representatives being included, together with several brief sketches of their careers. The Pawling & Harnischfeger Co. manufactures traveling cranes, both standard and special types, steam steering gear, grab buckets, drilling and boring machines, wall trolleys, hoists, etc.

Trade Notes

The Pittsburgh Emery Wheel Co., Pittsburgh, manufacturer of emery, electrolite, incordite and corundum grinding wheels, announces the removal of its office from the Park building, Pittsburgh, to Rochester, Pa.

"Fabroil Gears" is the title of a handsomely illustrated catalog showing the various applications and uses of gears made by the General Electric Co., Schenectady, N. Y., formerly known as cloth pinions. The variety of uses for these gears involves almost every conceivable type of machine. It is claimed that these gears will outwear iron or brass and are proof against damage from water, oil, dryness or temperature changes. They make silence possible in gear trains.

At the recent annual meeting of the Blystone Mfg. Co., Cambridge Springs, Pa., officers for the ensuing year were elected as follows: W. J. Pees, president; Dr. C. L. Smith, vice president; Luther G. Conroe, treasurer and general manager; H. J. LeFevre, secretary and manager of sales. The directors follow: J. A. Bolard, W. J. Pees, Luther G. Conroe, Dr. C. L. Smith, F. A. Wildman, J. F. Mather and H. J. LeFevre.

The Lockhart-Hodge Co., Inc., 22 Waverly street, Buffalo, manufacturer of safety guards for woodworking equipment, is sending to the trade a circular showing the different types of guards which it manufactures. These include guards for saws, shapers, joiners, etc.

Northern Crane Trolley

Extensive improvements in trolleys for heavy traveling cranes recently have been made by the Northern Engineering Works, Detroit, and the new trolley is shown in the accompanying illustrations. The primary considerations in the design were safety as regards strength and the protection of working parts, together with accessibility and rigidity. Durability in gears and other moving parts has been sought by designing them so they run in an oil bath which affords protection from dust and grit. The construction is such that the covers of the gear cases must be in place or the gears cannot run; this prevents the accidental omission of the gear covers in assembling the trolley after inspection or repairs.

Each train of back gears is mounted in a single frame; the bearings are bored in line and are capped and fitted with through bolts. The bearing liners are bronze. The hoisting gear train from the motor armature to the drum gear is carried in a single casting which tends to insure permanency of alignment. The drum gear is enclosed with a case of the same general type as that used for the hoist gearing. There are no overhung gears. The gear covers are castings and the joints are planed in order to make a tight construction and prevent the leakage of oil. The covers also are provided with large manholes for purposes of inspection and oiling.

The trolley is provided with a double brake system and a limit stop for the control of the hoisting block. The wiring is placed in steel conduits. This trolley is built in a range of capacities from two to 125 tons for either mill or standard service. The mill service trolleys have axle bearings of either the vertically or horizontally capped Master Car Builders' type.

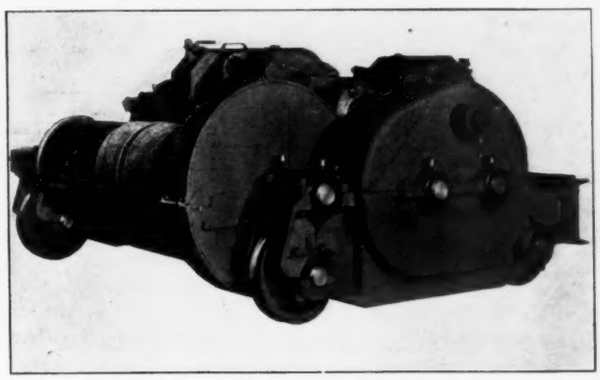

FIG. 1—CRANE TROLLEY WITH GEARING ENCLOSED

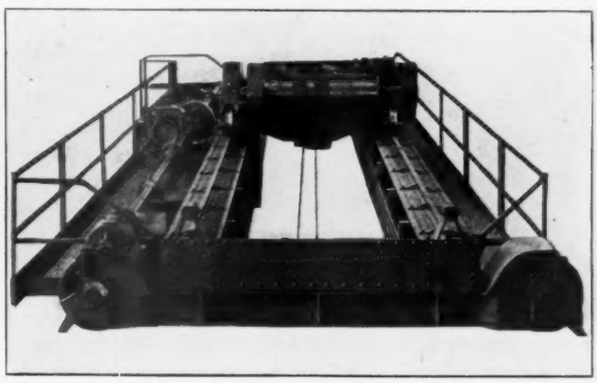

FIG. 2—THE TROLLEY IN SERVICE

Problems Involved in Industrial Pioneering

A Discussion of the Questions to be Considered When Locating a Foundry in a New Territory

By L L Anthes

WHEN the growing demand for a commodity brings a manufacturer face to face with the necessity of increasing his production, he is forced into serious communion with his *business soul*. If his trade extends over a far-reaching territory, he probably asks himself, "Shall I enlarge my present plant, or are conditions such that I can or should build in the territory farthest from my present manufacturing operations and thus have the advantage over my competitors in the matter of quick distribution?" The question is certainly a poser and the viewpoints from which it may be regarded are many. If the part of the country from which these increased demands for industrial products emanate, is more or less untried from a manufacturing standpoint,—the problem is more difficult. He may be a thorough master of the local conditions which influence his present place of business, but pioneering (and it is nothing more or less than industrial pioneering) brings with it new experiences, new conditions and invariably unthought of contingencies.

In this resume, I am dealing with the foundry business in particular and I speak with the authority of one who *has gone through the mill* and possibly the mill of adversity. While it is not my desire to intimidate those of adventurous spirit, yet I intend to commend to their forethought certain conditions and probabilities that might not have occurred to them, but which experience has taught me exist in the shape of hard facts. We will deal with a more or less concrete instance and endeavor to show how conditions peculiar to the North American continent are bound to influence industrial progress.

A foundryman produces a tariff-protected commodity which in addition to having a large demand in his immediate vicinity, also is used extensively in a territory a thousand miles or more from the point of production and a territory given over mostly to agriculture. During the years of unusual prosperity the demand exceeds the production; the local market, that is, the market within a reasonable radius of the manufacturing centre, for various reasons is served first and the more distant market suffers a shortage. Immediately there is an outcry from the starved territory sometimes followed by an appeal to the government to remove the protecting tariff in order that needs may be supplied as the country's own protected industries cannot meet the demand, and as the farmer has little sympathy for the protection afforded the manufacturer and as the agricultural community has no small voice in political matters, it is up to somebody to *move*.

It is usually on the wave of prosperity that the manufacturer is possessed with the feeling that expansion is imperative unless he relinquishes a market he can no longer hold with his present facilities. He estimates the total consumption of the distant territory and its possible increase, at the same time bearing in mind the development of the home or local market. If he decides that he can best serve his trade in the distant territory by the erection of a plant there, he begins to prospect, providing he is willing to assume the extra overhead it will entail, and take chances as to profits.

He considers the advantages and disadvantages of certain locations — the large local demand offset by high taxes if he chooses a city, or low taxes and incidental disadvantages should a small town be his choice—whether the best centre for distribution is more favorable to a locality where raw material, power, labor, fuel, etc., are more accessible—in short, what point holds out the most advantages towards ultimate success.

Where there is rapid development in a new country, there is also what might be termed a frenzied optimism. Each hamlet sees in the distant future its own prominence among the great cities, and one of the fondest desires of these would-be Chicagos is to become a manufacturing centre. An industrial commissioner is engaged "to boom the town" and many inducements in the form of free sites, free power, exemption from taxation, etc., are flung in the face of the prospecting captain of industry. Little wonder if he is dazzled by the glowing recital of golden opportunities. But a word of warning here. Inducements such as are offered by these untried and often diminutive localities should be the last and not the first consideration of the *industrial locator*. If he is shy on capital and cannot start his plant without these aids, the problem is entirely different. But it has often been proven that where the facilities for manufacturing and distribution are best there is the least offered gratis. But after he has considered his location from the standpoint of freight hauls, raw material and labor, together with the advantages of distribution, if the community is keen to give him something, let him take all he can get for he will need it!

Often there is some particular element which makes for success in a certain line of business, such as power, fuel, raw material or labor, and where this particular element is most accessible it is wise to weigh what disadvantages there may be against it before an ultimate decision is reached.

Some commodities are so largely used in a big city that the immediate local consumption alone may be a big consideration after the matters of higher taxation, cost of site, cartage and other expenses incidental to a metropolitan centre have been considered.

Always must be considered the inevitable competition. An iron commodity usually is manufactured on a small margin depending on tonnage for profits, and being a commodity, the element of competition is never removed no matter how far away your competitor may be. This factor regulates your price. Furthermore, a distant market is more likely to be a dumping ground for your competitors in times of depression, so you must be resigned to meet this condition of affairs.

Railway rates and railway hauls are no slight determining factors for failure of success. Where a country is sparsely settled and topographical conditions are against cheap railway operation, you invariably have high freight rates. Added to this, though the raw materials essential to your particular line of manufacture may not be far removed, the handler of these raw materials posts himself as to your necessity and sometimes you have to pay more for your requirements than if you brought them from some more distant point; in short, you pay a premium for quick service.

Owing to the high cost of cartage, which is in line with the higher cost of living in these new settlements, it is almost unnecessary to state that a plant should be served by a railway spur

Presented at the Chicago meeting of the American Foundrymen's Association.

where buying and selling are done in carload quantities. If a foundryman is situated where he can secure a low *summer rate* on account of lake navigation, let him make sure that he is going to save sufficiently to warrant the large outlay of capital, before navigation closes, for raw materials to carry him through the winter. For he has to buy at a time when prices are usually high and he may find himself financially crippled before spring.

Railroads, as a rule, are not favorable to manufacturing establishments which tend to reduce their long hauls on finished articles at high classifications. Then again, railroads are not inclined to give a wide margin of variation between raw and finished materials where manufacturing is likely to be detrimental to their own interests. So the manufacturer, in a new territory cannot hope to have much advantage over his distant competitor through the difference between freight on raw and finished materials. In fact there are points beyond the *pioneer* to which his competitor can ship at a lower rate than he can, though his competitors' goods have to come double the distance, and on top of this our poor pioneer is paying a much higher rate on all his raw material. When you take into consideration the fact that the heavy freight rates on coke, sand and fire-brick, in short, on everything but iron, contributes nothing to tonnage, and that the combined freight on raw materials may exceed the freight on the finished article over the same mileage, one realizes the significance of high freight rates. Then if you are close to the boundary line of a more thickly populated foreign power with lower freights, then what advantage you have in tariff may be offset by the lower freights accorded your foreign competitor.

Climatic conditions is a feature that must not be overlooked. Are weather conditions such that your plant can be economically operated the year round? Where conditions are such that you have to contend with thermometer extremes of 50 degrees below zero in the winter and 90 degrees in the shade in the summer, you must of necessity have a costly structure if your employes are to work in comfort. And in these newer districts building is expensive and labor high.

This brings us to the problem of labor —a live question no matter where you are located. The piecework basis of payment is now pretty well established in the manufacture of iron commodities, and in order that the cost of production may be kept as low as possible, our *pioneer* realizes that he must endeavor to introduce the same system in his new venture. Presuming that piecework is an innovation for the district, how is he to set about introducing it? If there is a labor union in the city for the workmen of his particular trade (and there probably will be) he is met by opposition at once. He must bring with him some of his old hands, men upon whose loyalty he can depend, and who are capable of being pacemakers.

Considerable tact and patience will be required breaking in the unskilled labor he will have to draw upon and he will have a year or more of trials in the form of bad castings, accidents and other drawbacks incidental to creating intelligence out of ignorance. As for the skilled labor he will require, it is safe to say the wages will be high and the workmen independent, and the same may be said of unskilled labor. With depressed commercial conditions your men become more tractable, but that is the time when you least require them. Some manufacturers find it advisable to run their plants to capacity during the long winter months, taking advantage of the more plentiful supply of labor when a great portion of outside work is at a standstill and men prefer an inside job when it is cold. This means an accumulation of stock and the tying up of considerable capital.

One must go through the cycles of good and hard times before he is in a position to feel that he can gage trade conditions and possible contingencies with a fair degree of accuracy. He may swing along merrily on the crest of a boom year and between seasons work to capacity to be ready for the expected rush when trade again opens, but a depression with its accompanying low prices may settle upon the country and the demand for his goods fall off, and he finds himself with a large stock of manufactured material which he is unable to turn over and which he is forced to carry until such time as conditions right themselves. He has the alternative of closing down his plant with the prospect of reorganizing expenses when he opens up again (for men soon scatter in a new country especially where railroad construction is carried on extensively and farming holds out opportunities), or of operating way below capacity with a disproportionate overhead, which probably means at a loss, in order to hold his men together. And then in a new country there is more or less land speculation and you will find that many of your men will be affected by the seeming opportunities of making some easy money by investing their wages in options or lots. This has an unsettling tendency and the men cannot keep their minds on their work. The high rate of wages paid also puzzles the employer as to what extent he is justified in the recovery of wasted products from his plant—whether the cost of recovery may not be higher than the value of material saved. No matter how thoroughly the pioneer understands his costs in his old established plant he will find that new conditions bring about new cost factors and a radically new cost basis will be required in his new shop. Local conditions will intrude themselves and must be treated with proper respect. A new territory is very much like a foreign country and local prejudices and customs must not be regarded lightly. One must adapt himself to conditions no matter what his opinion of these conditions may be. He must go about improving these conditions where they need improvement without creating antagonism which may mean his downfall. He will find it to his advantage to co-operate with other manufacturers in his district for the betterment of general manufacturing conditions and where his neighbors have long been established in business he may find it necessary to take the initiative, exercising considerable tact, before he can gain the support of those who have possibly resigned themselves to existing conditions and are in no mood to be shown by a newcomer. And then again they may be in a position to show him a thing or two which will possibly make him less cock-sure of his own ideas as to how things can and should be done.

Where a district has grown without the aid of manufacturers and the demand for commodities is large, the jobber or wholesale distributor is usually found to be strong and often antagonistic to a manufacturer entering a field which he has come to regard as his own. Then arises the question of mutual protection and the problem of trade policy.

One of the big things to consider in laying out a new plant is what improvement one can make over his present process of manufacture. The question of machine molding, continuous pouring and labor-saving devices, etc., will present themselves. Extreme caution is advisable in this direction and the foundryman must not only consult with experts, but should inquire into the success or failure other manufacturers in similar lines have met with. Where expensive machinery has been installed it is usually proven that the machine must be kept working nearly to capacity to warrant the investment. Very often the factor between failure and success will be found a very small one indeed, though none the less positive.

The foregoing review may seem an array of formidable arguments against breaking new ground; but they are actualities, and if one considers them carefully their force appeals to him.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Portland Forge & Foundry Co., Portland, Ind., has been incorporated with $80,000 capital by J. A. Long, L. G. Holmes and C. C. Cartwright.

The Continental Foundry Co., Anniston, Ala, has been incorporated with $50,000 capital by G. Schumacher, Emily R. Schumacher and C. H. Young.

The Alloy Foundry Co., Akron, O., has been incorporated with a capital of $1,000 by S. C. Gresham, E. F. Kibler, W. A. Lang, L. H. Wade and J. L. Snyder.

The Stephens' Machine & Foundry Co., Lawton, Okla., has been incorporated with $10,000 capital by Fred Cowell, J. R. Yarborough and B. R. Stephens.

The Joliet Wrought Iron Washer Co., Joliet, Ill., has been incorporated with $20,000 capital to engage in the manufacture of castings for building purposes. The incorporators are J. H. Garnsey, M. F. Lennon and others.

The Joliet Foundry Co., Joliet, Ill., has been organized by E. B. Clark, formerly superintendent of the Buda Co, Harvey, Ill. The new company has acquired the Enterprise foundry and will commence operations March 1.

The American Brass Mfg. Co., San Francisco, Cal., has been incorporated with a capital of $25,000 to engage in the operation of a brass foundry. L. H. Handy, 589 Post street, M. A. Whittle, H. C. Johnston, W. J. Phillips and A. L. Studebaker are the incorporators.

The Edwards Lighting Fixture Co., 65 East Lake street, Chicago, has been incorporated with $25,000 capital by L. J. Gerorgen, J. L. Cushing and L. V. Hult. The company operates a brass foundry, machine shop and plating, polishing and spinning departments.

New Construction

The Crescent Brass Mfg. Co., Reading, Pa., will erect an aluminum foundry.

The Miami Brass Foundry Co., Dayton, O., will erect a foundry at a cost of $10,000.

The Benton Harbor Malleable Co., Benton Harber, Mich., contemplates the erection of a new building, 50 x 150 feet.

The Farrell-Cheek Steel Foundry Co., Sandusky, O., is erecting an addition which will approximately double the capacity of its plant.

E. A. Rawitzer and E. B. Derome, Oakland, Cal., will erect a foundry on Fifty-ninth street at a cost of approximately $1,500.

E. D. Cameron, Mattoon, Ill., has leased and will put in operation the foundry of the Brazil Machine & Foundry Co., Brazil, Ind., which has been idle for some time.

The Wyomissing Foundry Co., Wyomissing, Pa., has purchased a site on which it will erect a plant for the manufacture of semi-steel castings and specialties.

The Wheeler Foundry Co., Inc., Worcester, Mass., contemplates the erection of a plant early in the spring. Arthur Miller is general manager.

The Whitin Machine Works, Whitinsville, Mass., is constructing a 50 x 200-foot addition to its foundry, which will increase the capacity 50 per cent.

The John Davenport Foundry Co., manufacturer of piano plate, Stamford, Conn., is establishing a branch plant in Montreal, Can., for the purpose of extending its Canadian business.

The Tallman Brass & Metal Co., Hamilton, Ont., contemplates building an addition to its plant. The company manufactures brass and bronze lighting fixtures and specializes in brass, bronze, copper and aluminum castings.

The Western Iron Works, Manitowoc, Wis., is transforming its foundry and machine shop into an aluminum foundry and has changed its name to the Grimm Aluminum Castings Co. Plans include the erection of an addition. Roland Grimm is general manager.

NEW TRADE PUBLICATIONS

SMALL MOTORS.—A bulletin recently issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is devoted to small motors of alternating and direct current types. These motors are furnished in various capacities from 1/20 to one horsepower.

PNEUMATIC TOOLS.—In a 4-page bulletin issued by the Monarch Pneumatic Tool Co., East St. Louis, Ill., various types of drills, wood borers, riveting and chipping hammers are described and illustrated. Tables giving the size, weight and capacity of these tools also are included.

AIR COMPRESSORS.—In a bulletin recently issued by the Chicago Pneumatic Tool Co., Chicago, fuel oil and gas-driven air compressors are illustrated and described and their application to the unit system of air power plants also is illustrated. These compressors are described in detail and various applications are shown.

CRANES.—Maris Bros., Philadelphia, recently have issued a series of bulletins devoted to their various types of cranes, including double beam hand cranes, single beam cranes, I-beam trolleys, chain hoists, combined hoist and trolley, freight handling and transfer cranes. The bulletins describe these cranes in detail and their application to various classes of work.

HEAT-TREATING FURNACES. — In a four-page bulletin, issued by the Quigley Furnace & Foundry Co., Springfield, Mass., underfired, temperature heat-treating furnaces using gas or oil fuel are illustrated and described. The furnaces are adapted for annealing, hardening, tempering and case-hardening as applied to the making of tools, dies, taps, punches, cutters, screws, springs, machine parts, roller bearings, sheet metal stampings, spinnings, etc., requiring great uniformity of temperature.

STEEL SASH.—An unusually complete and attractive catalog covering various types of steel sash, sash operating devices, steel partition, counterweighted sash, etc., has been issued by the David Lupton's Sons Co., Philadelphia. This catalog, No. 8, supersedes previous editions. Diagrams showing the section frames of various types of steel sash are presented, together with tables giving complete dimensions. Numerous illustrations are included in the catalog showing buildings fitted with Lupton sash.

ANODES AND PLATING SALTS.—A bulletin describing a line of anodes and plating salts recently has been issued by the Munning-Loeb Co., Matawan, N. J. In addition to purely descriptive matter it contains information on anode characteristics, efficiencies, and the effect of different shapes that should be of interest to platers. The bulletin contains a number of interesting illustrations showing various stages of anode decomposition. A brief chapter also is devoted to a discussion of single and double nickel salts.

GRAPHITE CRUCIBLES.—In a 20-page booklet issued by the Joseph Dixon Crucible Co., Jersey City, N. J., information is given regarding steel melting crucibles, file crucibles, crucible covers, tilting furnace crucibles, retorts, bottom pour crucibles, stirrers, skimmers, dippers and self-skimming crucibles. Several pages are devoted to general hints covering the use of crucibles and their service in fuel oil furnaces. A table of sizes of crucibles also is included. In addition, foundry facings and highly refractory cement for the repair of worn or cracked fire brick also are described.

HEAT RECORDING INSTRUMENTS.—An exhaustive bulletin describing various types of indicating and recording thermometers and pyrometers has been issued by the Foxboro Co., Foxboro, Mass. The construction details of the instruments manufactured by this concern are fully covered and a large number of specimen charts showing the continuous graphic temperature records are presented. Price lists and specifications also are included, together with details regarding protection tubes, chart files, etc. Another bulletin issued by the Foxboro Co. describes differential recording gages in an equally comprehensive manner.

BLOWERS.—A 16-page bulletin issued by the B. F. Sturtevant Co., Hyde Park, Mass., is devoted to steel pressure blowers for supplying air to cupolas and forges. The blower consists of a cast iron shell, within which revolves a steel plate fan having a diameter somewhat less than that of the blower casing and mounted on a steel shaft, the ends of which are supported by bearings. The openings in the two sides through which the shaft passes form inlets for the air, which is given a centrifugal motion by the rapidly revolving fan wheel and is delivered from the tips of the blades to the tangential outlet. The pressure at which the air is discharged depends upon the speed. The blower is described in detail. Methods of driving also are illustrated. An interesting table of diameters of blast pipes required for steel pressure blowers also is included.